INPUT

MANAGEMENT PLANNING PROGRAM IN INFORMATION SYSTEMS

VENDOR WATCH REPORT

SOFTWARE PRODUCTIVITY TOOLS: UPDATE AND OUTLOOK

DECEMBER 1983

MANAGEMENT PLANNING PROGRAM IN INFORMATION SYSTEMS

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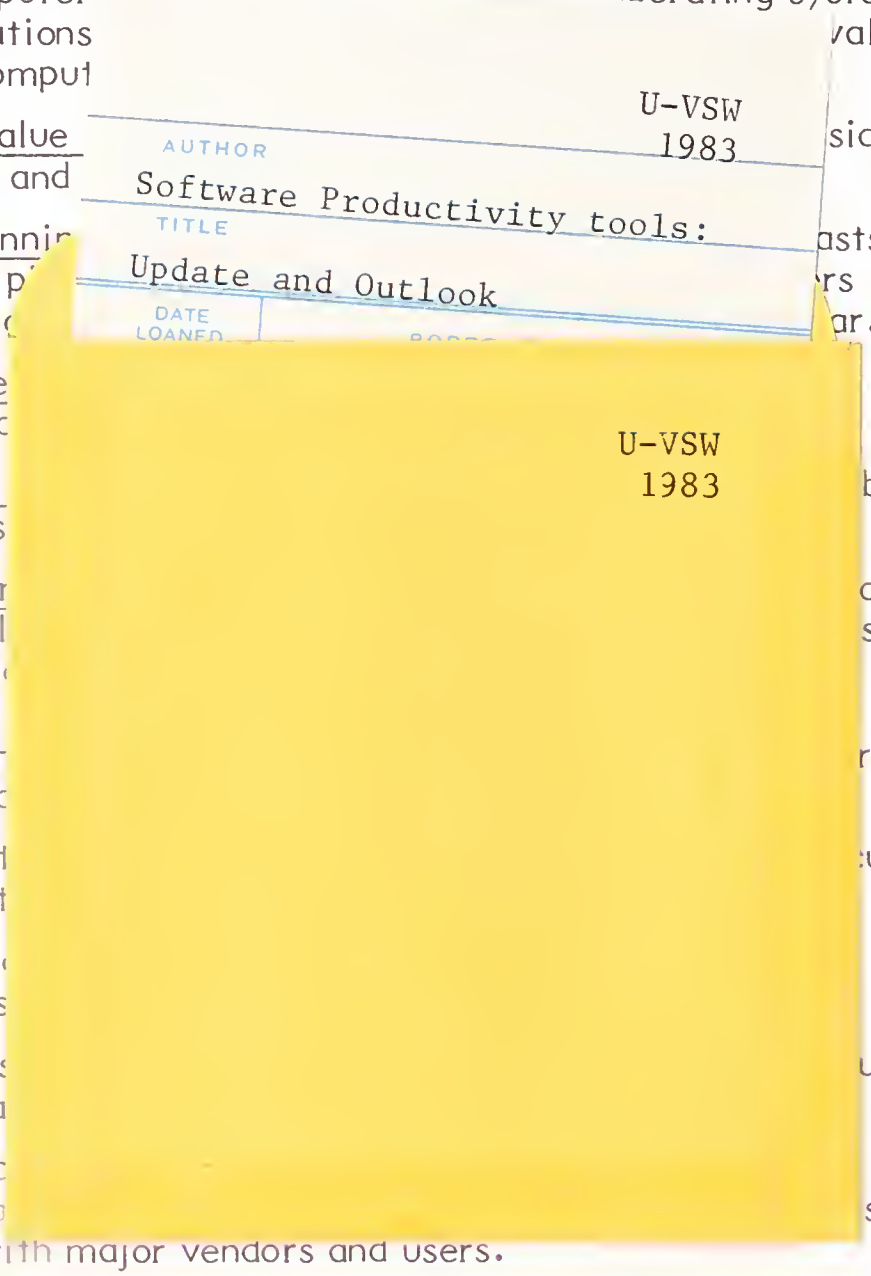

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SOFTWARE PRODUCTIVITY TOOLS: UPDATE AND OUTLOOK

CONTENTS

SOFTWARE PRODUCTIVITY TOOLS: UPDATE AND OUTLOOK

EXHIBITS

I INTRODUCTION

A. OBJECTIVE

- The objective of this report is to help information systems management increase systems development productivity by alerting them to the opportunities and challenges in the use of software productivity tools (SPTs) that will be arising in the next few years.

- Despite the continuing growth of packaged software, application development methodologies, and programming aids, there is still a systems development bottleneck. A credibility gap still exists between information systems (IS) departments and end users, and the backlog of development projects is growing. Characteristics of this backlog are complex system projects, long development times, and high development and maintenance costs.

- The user community has begun to search for alternatives. These include end-user computing facilities such as personal computers and information centers (using fourth generation languages with corporate or user data bases). While they appear to solve the backlog problem, these alternatives may introduce severe control and management problems.

B. SCOPE

- This report is a follow-up to INPUT's December 1980 multiclient report, Improving the Productivity of Systems and Software Implementation. The basic findings of this report still to need emphasis today:

  - Current "solutions" do not solve productivity problems.

    . Technical aids (SPTs) and organizational changes (e.g., charge-back, distributed processing) are only a small part of the answer.

  - Current perceptions of the problem are too limited.

    . Many IS organizations are too technically focused and view productivity as a problem of generating a number of lines of code per day, of meeting schedules, and of meeting budgets.

  - A productivity strategy is required.

    . A commitment to quality, user involvement, broad-based management, and effective personnel are requisite before productivity tools can be effectively employed.

  - There is no single strategy for all organizations.

    . Furthermore, successful implementation of any strategy will take time and commitment.

  - Stages of productivity development is a key concept.

  - . Individual productivity initiatives must be synchronized with the IS organization's current stage of development.

- Self-assessment.

  - . There is a continuing need to analyze a company's stage of productivity development and whether it is using SPTs appropriate for that stage.

- There are two basic considerations that are addressed in this current report on software productivity tools:

  - All SPTs need a well-planned and receptive environment (as illustrated in the above findings) before productivity can be achieved.

  - New SPTs are evolving (e.g., prototyping) that are more likely to increase productivity because they span the entire development life cycle and focus on requirements definition and design.

- This report will discuss the following SPT issues:

  - The changing character of systems development.

  - The evolution of SPTs.

  - New SPT-related challenges facing IS managers.

- Included is a classification of SPTs, including a review of several that have been successful, and a trend projection for SPTs in the near future. Some of the SPTs discussed in this report offer new development methodologies, others add to the potpourri of programming aids, and a few hint at revolutionary solutions.

II EXECUTIVE SUMMARY

A. PURPOSE

- Although the industry has provided the IS manager (and now the end user) with numerous software productivity tools, software productivity has not increased as fast as the demand for new systems. The software development backlog is still growing.

- User frustration with the development bottleneck is at a boiling point, and for the first time they now have a viable option - to do the development themselves. This pressure toward user control of the information resource frequently occurs in a fragmented, uncontrolled manner with only short-term objectives in mind.

- The IS executive is challenged with:

  - Providing a receptive and planned environment for effective use of SPTs.

  - Selecting appropriate new SPTs for the company's stage of development.

  - Balancing the tension between user control and IS control of the development process.

B. FINDINGS

- Software productivity must include:
  - Timely system completion.
  - Satisfying budgetary objectives.
  - Satisfying user requirements and expectations.
  - An efficient operating system.
  - A system that is easy to modify.
  - Compatibility with existing systems.

- Software productivity tools do not solve the productivity problem. They are only a small part of an improved productivity strategy. A strong, disciplined systems development methodology, user participation, commitment to quality, and broad-based IS management are prerequisites to employing SPTs successfully.

  - User awareness and understanding of IS and user presence in the systems development process is continually increasing.
    - Many users are developing systems by using personal computers and information centers.
    - There is a need to balance the tensions between user and IS dominance of the development process.

- Information systems are becoming increasingly complex and require more support from IS for successful design and implementation. These systems are integrating functions, requiring access to multiple data bases, and function in an on-line environment.

- The backlog in systems development has given rise to a trend for more experimentation with new and revolutionary tools.

  . Distributed development, prototyping, personal computing, and user-developed systems are all being used to attempt to reduce this backlog.

  . There is a need to try leading-edge SPT technology while maintaining controls on the information resource.

- While early SPTs were aimed almost completely at programming, the newer SPTs span multiple phases in the system development life cycle, especially on requirements definition, systems design, and data base design.

  - Some new SPTs (e.g., prototyping) offer broader solutions to the productivity problem than earlier SPTs, and inherently attack problems such as user involvement.

C. RECOMMENDATIONS

- In order to successfully use SPTs to improve software productivity, IS management must implement a strategic productivity plan with full management commitment and support.

- The focal point of this plan must be a well-defined systems development methodology (SDM), i.e., a system for building systems, which, in turn, defines specific requirements for automated software productivity tools (SPTs).

- Users must participate in development of the plan, as well as participate on systems development teams and selection committees for new SPTs.

- Selection criteria and usage guidelines should be established in order to maintain control of SPTs.

- IS needs to assess its stage of development in order to successfully apply appropriate SPTs.

- IS must identify and analyze the effectiveness of current software productivity tools.

- INPUT has identified five stages of productivity developments that must be addressed by different strategies. Exhibit II-1 lists these stages with their typical applications and examples of productivity tools that are effective for that stage of development.

- Software productivity tools are not a panacea. They are, as their name implies, tools for improving productivity and for satisfying IS and corporate objectives.

EXHIBIT II-1

STAGES OF PRODUCTIVITY DEVELOPMENT

STAGE/ CHARACTERISTIC	APPLICATION TYPE	PRODUCTIVITY TOOLS
Zero: Chaos	Functional Cost Reduction, Batch	Third Generation Languages COBOL, FORTRAN, PL/1
One: Control	Integration of Operating Divisions	On-Line Monitors: TSO, CMS
Two: Quality	Cross Functional Integration, Data Base, On-Line	Structured Design, Data Base-Oriented Languages
Three: Efficiency	Large-Scale Data Base, On-Line, Specialized and and Strategic Orientation	Automated, Integrated Tools; Limited Direct User Access
Four: Value	"What if " and Retrieval by User Central Group Does Technical Systems and Maintenance of Strategic Data Base Resource	Widespread Direct User Access; Fourth Generation Languages; Select Software Building Blocks

III ISSUES

A. IMPORTANCE OF SOFTWARE DEVELOPMENT PRODUCTIVITY

- Improvements in productivity in the system development process have been negligible. This is in the face of abundant SPTs and significant improvements in hardware productivity. The resulting bottleneck in systems development can range from inconvenience to affecting the overall success of a company. There is still a shortage of qualified programmers and systems analysts.

- The IS operation has not improved its "we/they" image with its users. In fact, this image has noticeably worsened as users' expectations soar because they themselves are increasingly knowledgeable in systems and programming. IS is basically still developing systems as they have for the past 20 years. Credibility continues to wane and systems development has begun to move into the user community where there are no controls.

- Corporations still suffer from an information gap (i.e., a wide variance between what users need and what automation can provide). It is vital that this gap be filled through increasing the overall productivity in systems and software development.

- It is important to note that "productivity" must include:

  - Timely completion of a system.

- Meeting budgetary objectives.

- Meeting user requirements and expectations.

- Creation of an efficient system.

- Flexibility for modifications.

- Transferability.

- Compatibility with existing systems.

B. CHANGING CHARACTER OF SYSTEMS DEVELOPMENT

- The systems development process is in a state of flux. This is a direct result of the growing unsatiated information demand. This state of flux in systems development is changing the character of SPTs. Main factors currently reshaping the systems development process include:

  - Increase in the availability of automated tools for end users. The computer industry has enthusiastically responded to the information demand in two ways:

    . Personal computers providing user-friendly software.

    . Information centers providing limited access to production data bases and creation of personal data bases via fourth generation languages. The users can now bridge the information gap on their own with fourth generation languages. However, this bridge (which is often built by inputting data from the users' own

sources) does not ensure accurate and reliable results in the output produced by the end user.

- Increase in user awareness of IS. The educational community has responded by making the business professional and technical user more knowledgeable about information systems, programming languages, software packages, and SPTs.

- Increase in user presence in the development process. Users participate more in the process and are frequently members of development teams. There is increasing pressure for user-developed systems. Today's user also wants more control of the information resource.

- Increase in complexity of modern information systems. Today's system requirements are more difficult to define than those of early systems. At the same time, systems have broader impact throughout a company. They are more integrated, and they required data base technology in an on-line environment.

- Trend toward more experimentation. Management has been willing to try new approaches to systems development, e.g., distributed development, prototyping, personal computing, and user-developed systems.

C. RISE AND FALL OF SPTs

- In analyzing the rise and fall of SPTs, it is helpful to look at the evolution of development techniques. Four basic techniques are currently available.

1. CUSTOM PROGRAMMING

- Early SPTs grew out of a need for improving the productivity of programming (e.g., debugging packages, JCL procedures, and report writers). SPTs to support implementation will continue to grow, but are not the sole answer to solving the overall productivity problem. Effective systems design is becoming a more important factor to productivity than coding due to the increasing complexity of systems and the need to share data with other systems.

2. APPLICATIONS SOFTWARE PACKAGES

- Applications software packages have been one of the most successful SPTs even though they normally need considerable modification when installed (conventional SPTs are often utilized to assist in this process). In spite of the trend toward increasingly complex systems and newer development techniques (e.g., prototyping), it is likely that application packages, as they currently exist, will continue to enjoy the growth they had in the past. In fact, INPUT forecasts that user expenditures in the U.S. will grow at a compounded average annual growth rate of 29% through 1988.

- Application packages utilizing older file structure technology and procedural code, such as COBOL, will be replaced by newer architectures. The software package industry will make a major shift and will provide software utilizing relational DBMSs, giving their clients the ability to use prototyping development techniques and fourth generation languages for customization.

3. PROTOTYPING

- Prototyping is an emerging technology that depends on specialized SPTs (e.g., fourth generation languages) in order to easily change data structures. Prototyping is an important concept because it involves the user in its basic procedures, and it spans multiple system life cycle phases, focusing on data base

design. Exhibit III-1 illustrates the system's development life cycle in a prototyping environment.

4. USER-DEVELOPED SYSTEMS

- User-developed systems depend on specialized SPTs (such as the "calcs" and some decision support tools). These tools facilitate and accelerate implementation. The obvious advantage is to not have to translate the user requirements to systems professionals. The disadvantages include excessive use of computer resources, inferior development methods, and poor transferability of systems.

D. CHALLENGES FACING SYSTEMS DEVELOPMENT MANAGERS

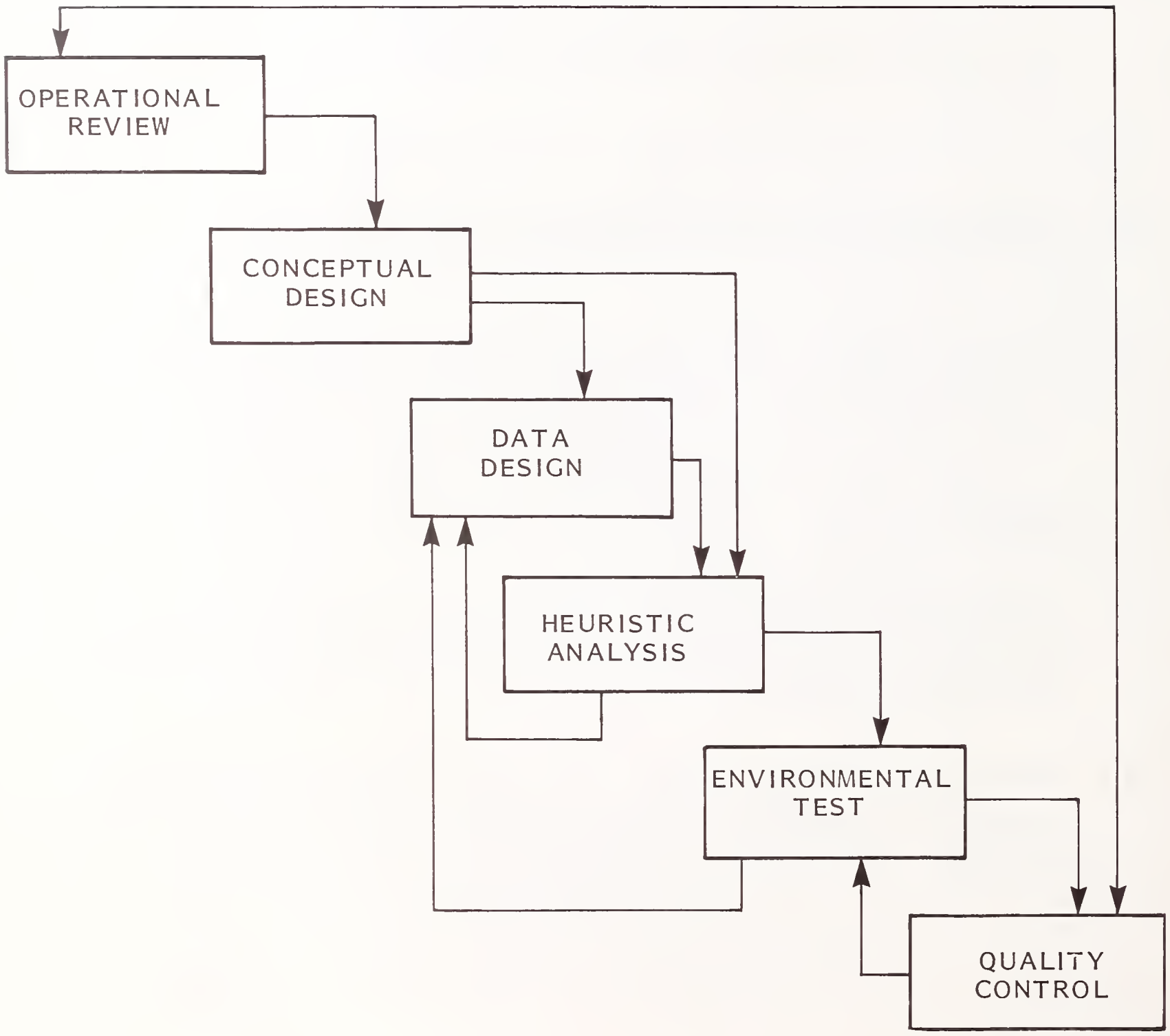
- The main challenge facing systems development managers is to offset the increasing pressures toward user dominance of the development process and to achieve balance between the IS and user communities. This will be difficult to achieve unless IS regains credibility by increasing systems development productivity.

- Another significant challenge is to maintain needed controls of the information resource while simultaneously introducing new development technologies that heavily involve users.

- These challenges attach urgency to the task of obtaining top management commitment to develop and sponsor an overall corporate systems productivity strategy.

EXHIBIT III-1

SIX ITERATIVE STEPS IN DATA-DRIVEN PROTOTYPING



IV SPT AVAILABILITY AND ACCEPTANCE

A. CLASSIFICATION OF SPTs

- It is important to recognize that today's SPTs include more than the implementation (programming) aids that we normally associate with software productivity.

- The following is a list of various classes of SPTs grouped into three general categories. Exhibit IV-1 provides examples. The first two categories correspond to two major phases of the systems development life cycle: pre-implementation (requirements definition and design tools) and implementation. New technologies have been grouped separately in a third category since they represent a new approach to software productivity, that is, they span the pre-implementation and the implementation phases of systems development. Products in this category are not yet widely used.

B. REQUIREMENT DEFINITIONS/DESIGN TOOLS

- Business or information systems planning (e.g., IBM's BSP).

- Data gathering/analysis techniques (e.g., Information Modeling).

EXHIBIT IV-1

CLASSIFICATION OF SYSTEM PRODUCTIVITY TOOLS (SPTs)

STP	EXAMPLES	SYSTEMS DEVELOPMENT PHASE ADDRESSED		
		Requirement Definitions	Design	Implementation
Artificial Intelligence	LISP Small Talk	X	X	X
Data Dictionary	Datadictionary (ADR) DB/DC (IBM) UCC-10 (UCC)	X	X	X
Data-Driven Prototyping	PDM-80	X	X	X
Design Methodologies	Structural Design (De Merco) Structural Analysis	X	X	
Information Planning	Business Systems Planning Information Modeling	X		
Modeling/Non-procedural Languages	Focus, Express, Easytrieve	X	X	X
Programming Aids	Program Utilities (CAPEX) Structural Programming			X
Visual Programming	Mapper, VisiCalc		X	X

- Structured analysis/design (e.g., DeMarco, Yourdon, SofTech, HIPO, and PRIDE).
- DBMS.
- Software aided (e.g., DDI - J. Martin, DSSD - K. Orr).
- Application prototyping.
- Data dictionaries.

C. IMPLEMENTATION

- Structured programming (e.g., SPF).
- Program code generators.
- Higher level retrieval languages (e.g., DYL 280, Easytrieve).
- Fourth generation languages (e.g., FOCUS, INTELLECT).
- DBMSs.
- Programming utilities (e.g., Capex, Optimizer).
- Systems management aids (e.g., Ditoo, JARS).
- Telecommunications monitors (e.g., CICS).

D. REVOLUTIONARY TECHNIQUES

- Visual programming (MAPPER, VisiCalc, etc.).

- Data-driven prototyping (PDM-80 from DACOM).

- Artificial intelligence (exploratory programming, e.g., LISP, SMALLTALK).

- As depicted in the chart, the earliest SPTs were intended to support programmers. These tools increased programming productivity, but they did not increase system development productivity. IS generally concluded that programming the wrong system faster would not solve the problem. New tools were developed to better define requirements. Still more tools are being developed to cover all phases of systems development life cycles, starting with systems planning and needs analysis continuing through performance monitoring.

E. CURRENTLY POPULAR SPTs

- Although isolated programming aids are in many cases applied as bandages to the hemorrhaging area of software productivity, they still have value and will continue to be acquired. This is especially so since about half of all software resources are devoted to the maintenance and enhancement of existing systems, and 90% of these systems are written in standard third generation languages (COBOL, FORTRAN, PL1).

- It is unlikely that these systems will be discarded for new technologies due to the following factors:

  - Functions are added on, not replaced.

- The technical criterion for new functions is compatibility, not perfection.

- The software market is in tools, not systems.

- Although the trend is toward high-level, natural languages, COBOL or FORTRAN compatibility will continue to be important in the next 10 years, and tools to improve productivity in these languages will remain popular.

- Applications packages are still a major SPT for many companies, particularly in well-defined functional areas (accounts receivable, general ledger, accounts payable, and manufacturing resource planning, etc.).

- Systems development methodologies and project control systems, which have been in use since the early 1970s, are still very popular.

  - They provide a cook book approach to designing and implementing an effective system, giving IS and user management a feeling of security that the job is being done properly.

  - Another reason for their continued popularity is that they have provided more realistic cost and time estimates for systems projects.

- The main problem is that the functional decomposition system design approach that they follow assumes that user requirements can be fully and accurately defined. These systems must change to adapt to new technologies that are data rather than process-driven in order to continue their success.

- Hardware tools also continue to be a popular means of assisting the programmer. One of the biggest productivity aids for the programmer was the advent of on-line programming and job submission. When response time began to deteriorate, the minicomputer vendors introduced programmer worksta-

tions. Now micros are being utilized as workstations. Currently popular are larger format CRTs where a programmer can display 132 print positions (3278-5) or more lines of code (3278-4).

- The recently announced IBM 3290 neon display allows a programmer to simultaneously view up to four screens (e.g., program, a data file, a subroutine, and output).

- The IBM 3270 PC and XT/370 allow the programmer more intelligence on his terminal. In some cases, he is able to program and test off-line eliminating response time problems that most on-line development systems experience.

- Prototyping is becoming more and more widely accepted as an effective development methodology that is dependent upon fourth-generation languages and flexible DBMSs. Its popularity results from the ability to develop systems that more closely meet the user's needs in a fraction of the time the traditional approach requires.

- The primary reason is that it is a technology that incorporates into its basic procedures components of an effective productivity strategy (e.g., user involvement and broad-based management), which have been neglected in traditional methods. It is also successful since it integrates the design and implementation phases of development and does not assume that all the system's requirements can be defined in advance. Consequently, prototyping has the potential of making a significant impact in the improvement of overall systems development productivity.

- There are two basic approaches to prototyping:

  - Application ("closed" system) prototyping.

  - Data-driven ("open" shared data base) prototyping.

- Information modeling is becoming a popular technique for assisting in the analysis of needs and definition of requirements. Once a company's shared data has been accurately modeled, transactions that are required to support the data are readily definable.

- Data dictionaries have been available for a few years but have not yet had a dramatic impact on software productivity. Ultimately, they will be essential in solving the puzzle of productivity. The success of data dictionaries is a function of how well a corporation can model its organization from a data perspective. Data dictionaries provide the control mechanism for the successful development of all systems - reducing data redundancy, improving data quality, and increasing data availability to all users with a valid need for it. IS managers should consider data dictionaries in most new systems.

- DBMS technology continues to advance. An increasing percentage of newly developed applications use data base technologies.

F. SPTs DECREASING IN POPULARITY

- In general, there are few SPTs that have decreased in popularity during the past two years. SPTs that have proven themselves capable of providing help in any area of the system development process remain popular. While those comprehensive SPTs that integrate multiple phases of the life cycle (e.g., prototyping) will become the basis for the new wave of systems development, traditional programming aids will continue to thrive.

- SPTs that are primarily designed for batch processing (e.g., JCL checking) have begun to wane in popularity somewhat as batch processing is giving way to on-line systems. SPTs in support of on-line processing (e.g., screen managers) have been increasing in popularity.

- The traditional systems development methodologies will be replaced by more effective methodologies based on new SPTs that include the user more, and are data driven (e.g., fourth-generation languages, prototypes, and artificial intelligence systems).

- The advent of personal computers with their financial-planning-oriented software and information centers have heralded the decline of remote computing servicers' proprietary software services. Once such specialized and user friendly software was only available on outside services, but this type of software is now available on in-house computers and even personal computers, at much lower cost. An example of this is the financial analysis languages (e.g., FAL on G.E.), which are being replaced by "calc" software on PCs (e.g., SuperCalc). Some software packages that were once proprietary are now available for in-house installation (e.g., NCSS's NOMAD, IBI's FOCUS).

G. HIGHLY PROMISING SPTs

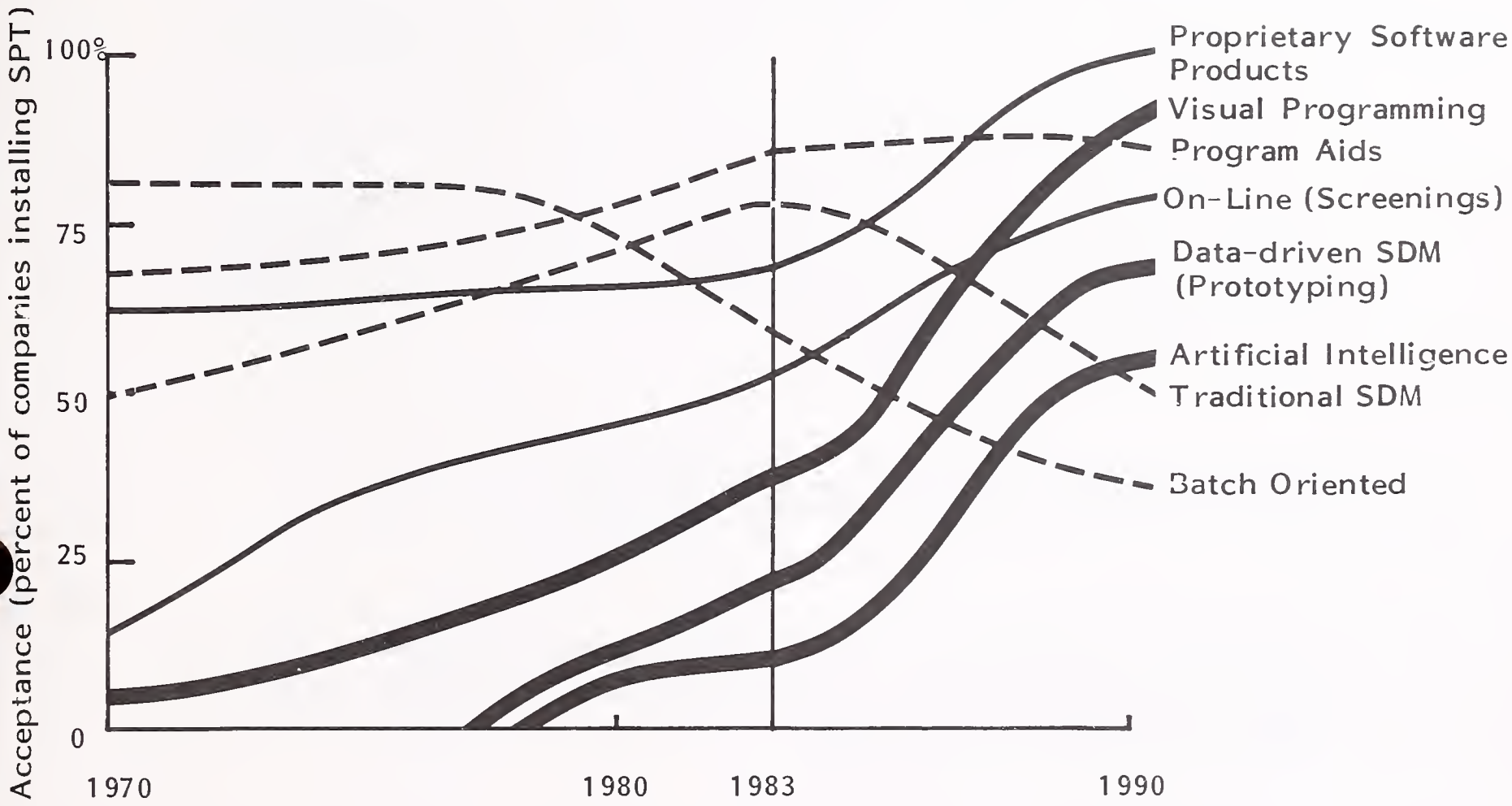
- Exhibit IV-2 contrasts the highly promising new SPTs with the declining, traditional ones.

- Prototyping was already mentioned as a popular SPT, but it should also be included in the promising category because its use has just begun to blossom, and its future impact will be significant.

- Artificial intelligence (AI) is a new, revolutionary idea. However, with information systems becoming increasingly complex, competent programmers in short supply, and current SPTs not solving the systems development bottleneck, this technology offers hope (several AIs were displayed at the last two National Computer Conferences (NCCs), e.g., LISP, SMALLTALK, PROLOG).

EXHIBIT IV-2

EMERGING AND DECLINING SPTs



= Emerging SPTs that are increasing in use

= Current SPTs that are increasing in use

= SPTs decreasing in use

- The main benefit is that AI is the concept of exploratory programming, that is, the deliberate interplay of systems design and implementation.

- Visual programming is yet another technique that will emerge as a valid SPT. Instead of the traditional languages that employ structural interfacing procedures, a visual interface is provided between the user and the system. The user (or programmer) simply draws a visual representation of how he would like the information to be entered or retrieved. Although this may sound simplistic, it is a concept that has been employed for some time in CRT-based word processing and more recently in personal computer software such as electronic spreadsheets. Visual programming represents a revolutionary approach to solving the productivity problem, a promising approach, especially if used in support of prototyping.

H. REASONS FOR SPT ACCEPTANCE OR REJECTION

- Acceptance or rejection of an SPT depends upon its consistency with IS's current stage of development. The SPT cannot be too far ahead or behind the IS department's skills and strategies.

- The viability of SPTs is directly affected by the quality of an IS department's systems development methodology and by the degree of integration of the SPTs and the methodology.

- Another key factor is the nature of the company's organizational profile, such as:

  - Highly or loosely structured.

  - Centralized or distributed operations/decision making.

- Current credibility of IS.

- Sophistication of user community.

- The stage of technological development is another acceptance criterion. An SPT may be ineffective if it doesn't take advantage of new technologies or methodologies.

V RECOMMENDATIONS

A. NEED FOR AN SPT STRATEGIC PLAN

- SPTs alone will not solve the productivity problem facing information systems departments. They can be effectively employed only after a viable system development methodology has been put into place. There is no cook book or methodology that applies to all companies. A specific plan is therefore required to make clear to all users and IS personnel who interface with software systems:

  - Corporate objectives and expectations.

  - Management commitment to quality and productivity improvement.

- There is increasing pressure toward user involvement (and even control) of the development process. A plan is required that provides direction for balancing user involvement with IS control. This plan must assist in defining roles for participants in the system development process.

- Since part of the problem has been an inadequate idea of productivity on the part of IS management, a plan would more completely define the specific goals of software productivity.

- Finally, a company needs to have a plan against which it can measure its performance in using SPTs.

B. CHARACTERISTICS OF AN SPT PLAN

- The SPT plan must have the following characteristics in order to be successful:

  - Top management sponsorship: corporate management must commit to the pursuit of improved productivity in the software development process. This plan should be incorporated into the overall business planning process.

  - A working tool for measuring progress: the SPT plan should not be put on the shelf once it is completed; it should become a tool to measure progress of SPT productivity against objectives.

  - All categories of SPTs must be included: all three categories outlined in Chapter IV should be addressed: requirement definitions/design tools, implementation tools, and revolutionary techniques.

- Components of an SPT plan:

  - Self-analysis and statement of current stage of productivity development: Exhibit V-1 describes INPUT's five stages of productivity and development are a good measurement of where a company stands. Each stage calls for a specific software productivity strategy, coupled with a specific system development methodology. The stages of development are not arbitrary or isolated but have an organic relationship that comes from successive motivating factors.

SYSTEM AND SOFTWARE PRODUCTIVITY SELF-ANALYSIS MATRIX

CHARACTERISTIC / STAGE	I.S. ORGANIZATION	APPLICATION TYPE	I.S. MANAGEMENT DESCRIPTION	CONTROL MECHANISM	PERFORMANCE CHARACTERISTICS	PRODUCTIVITY TOOLS
Zero: Chaos	Business Function "Owned" by User	Functional Cost Reduction, Batch	Pawn; Focus on Operations Working Toward Control	Verbal or Signed Project Request	Slow	Third Generation Languages: COBOL, FORTRAN, PL/1
One: Control	Centralized Business Function	Integration of Operating Divisions	Manager; Focus on Coordination, Working Toward Quality	Budget, Schedule	Cost Overruns, Slower, Backlog Growing	On-line Monitor TSO CMS
Two: Quality	Tech Specialist Matrix Plus Business Function, Project Basis	Cross-Functional Integration, Data Base On-Line	Director; Focus on Planning, Working Toward Efficiency	Formal SDM, Steering Committee	Backlog Stabilized, 80% on Time	Structured Design; Database Oriented Languages
Three: Efficiency	Matrix, Tech Specialist and Business Specialization (User Manager)	Large-Scale Data Base, On-Line Specialized and Strategic Orientation	Company Officer Concerns Beyond EDP, Working Toward Value	Hierarchical Steering Committee, Long-Range Plan, Productivity Measurements	On Time, Cost Within Budget	Automated Integrated Tools, Limited Direct User Access
Four: Value	Distributed; Central Group Does Common Systems, Technical Advisory	"What if" and Retrieval by User. Central Group does Technical Systems and Maintenance of Strategic Data Base Resource	Operating Management of Company; Focus on Survival, Growth, and Profitability of Company	Productivity Index, Value Index	Assumed, Not an Issue	Widespread Direct User Access; FGL Select Software Building Blocks

- Chaos is self-descriptive: a constant state of crisis that demands effort to control.

- After control has been achieved, the organization realizes that the semi-arbitrary mechanisms used to establish control must be modified to take into account the twin demands for increasingly complex systems and higher quality systems.

- Quality IS systems raise interest throughout the organization in the potential for IS to increase the efficiency and effectiveness of the entire organization. Many of the productivity initiatives begun in the quality stage are refined and expanded in the efficiency stage.

- The efficiency stage raises further expectations within the organization, in that user needs for information are met more predictably, and information in and of itself is viewed as having value alongside the other factors of production (labor, capital, materials).

- In the value stage, data processing is no longer seen as a separate, isolated activity but participates directly in the mainstream of corporate activities (as, for example, finance does now). It is in the value stage that truly large gains in productivity can be achieved, as users interact directly with the information needed to expand the market control and profitability of the entire organization.

- Statement of corporate objectives and expectations concerning productivity: this requires an analysis of the company's exposure relative to new technology and a definition of the criteria for software productivity.

- Definition of roles between user and IS staff: an organization for software development projects must be defined, specifying the relative roles of users and systems professionals.

- Definition of roles between central and distributed development: if the company has both a central and distributed development staff, their roles and control of SPTs must be defined and recorded.

- Selection of an appropriate design methdology: although a design methodology is an SPT itself, it is at the center of other SPTs and should be selected or developed early.

- Establishing guidelines and training for SPT use: once SPTs are selected, their use needs to be managed and controlled or they may be misused or even abused and become counterproductive.

- Inventory and analysis of current SPT effectiveness: in order to proceed with the plan, an evaluation of currently utilized SPTs must be conducted.

C. SUGGESTIONS CONCERNING SPTs

- Take a whole new approach to SPTs, and do not consider them a panacea for all the ills of development productivity. Realize that they are only one piece in a complex puzzle.

- Incorporate an SPT strategy into the long-range systems plan.

- Include the user in the development process. This is essential to the success of any SPT, especially those affecting requirement definitions.

- Develop internal expertise in the SPT in order to use it effectively.

- Do not be threatened by new techniques and get hooked into a methodology that is comfortable because it is familiar. A new SPT may provide greatly needed assistance.

- Educate users in the range of SPTs available for assisting in the development process.

- Do not lose control of the information resource or SPTs to an aggressive user community.

- View productivity qualitatively as well as quantitatively.

- Select SPTs that are flexible for change, not too complex, compatible with existing systems and languages, and that perform efficiently and accomodate growth.

D. WAYS TO INCREASE USE OF SPT

- Promote the capabilities and use of the available tools throughout the company. The user community should be aware of the SPTs, and their use should be encouraged within proper guidelines.

- Provide internal training courses on when and how to best use SPTs.

- Establish user groups whose purpose it is to share experiences and exchange ideas on how to increase productivity by using SPTs.

- Identify key personnel with a charter to provide ad hoc assistance to SPT users.

- Publish newsletters or bulletins that include how-to tips and success stories about productivity gains brought about by using SPTs.

- Set up an information center that becomes a central facility for achieving the above objectives.

- Employ a team approach (including users as members) on the selection of new SPTs and on the development of systems using existing SPTs.

E. SPT EXPANDING HORIZONS

- SPTs are no longer mired in the depths of the IS department. They are emerging into the user community and providing a mechanism for IS and the user to jointly develop information systems. Not only can SPTs improve program development productivity but they can also improve user relations. The true benefit of software productivity tools is the potential for increasing IS and user productivity. Used properly, SPTs can be a vehicle for satisfying IS's corporate objectives.

MANAGEMENT PROGRAMS: Designed for clients with a continuing need for information on a range of subjects in a given area.

- Management Planning Program in Information Systems - Provides managers of large computer/communications facilities with timely and accurate information on developments that affect today's decisions and plans for the future.
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- Financial Planning Systems Markets: The Next Five Years

CUSTOM STUDIES: Custom studies are sponsored by a single client on a proprietary basis and are used to answer specific questions or to address unique problems. Fees are based on the extent of the research work. Examples of recent assignments include:

- Organizing for Effective Software Development
- Corporate Plan for Utilizing CAD/CAM
- Annual ADAPSO Survey of the Computer Services Industry
- Analysis of Business Services for a Major Financial Institution
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- Study of Disaster Recovery Services
- Analysis of Software Maintenance Issues
- Review of Software Product Market Opportunities
- Analysis of Network User Requirements

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INPUT provides planning information, analysis and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company carries out continuous and in depth research. Working closely with clients on important issues, INPUT's staff members analyze and interpret the research data, then develop recommendations and innovative ideas to meet clients' needs. Clients receive reports, presentations, access to data on which analyses are based, and continuous consulting.

Many of INPUT's professional staff members have nearly 20 years' experience in their areas of specialization. Most have held senior management positions in operations, marketing, or planning. This expertise enables INPUT to supply practical solutions to complex business problems.

Formed in 1974, INPUT has become a leading international planning services firm. Clients include over 100 of the world's largest and most technically advanced companies.

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MANAGEMENT PLANNING PROGRAM IN INFORMATION SYSTEMS

RESIDUAL VALUE FORECASTS
FOR IBM DISK, TAPE, AND
PRINTER SYSTEMS

MARCH 1983

MANAGEMENT PLANNING PROGRAM IN INFORMATION SYSTEMS

OBJECTIVE: To provide managers of large computer and communications systems with timely and accurate information on developments that affect today's decisions and plans for the future.

DESCRIPTION: Clients of this program receive the following services each year:

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INFORMATION SYSTEMS PROGRAM

RESIDUAL VALUE FORECASTS
FOR IBM DISK, TAPE, AND
PRINTER SYSTEMS

MARCH 1983

RESIDUAL VALUE FORECASTS FOR IBM DISK, TAPE, AND PRINTER SYSTEMS

CONTENTS

RESIDUAL VALUE FORECASTS FOR IBM DISK, TAPE, AND PRINTER SYSTEMS

EXHIBITS

I INTRODUCTION

- This report on selected IBM disk, tape, and printer products is issued as part of INPUT's Residual Value Forecasting Services in the Information Systems Planning Program. Information contained in these reports is updated at least annually depending upon announcement of new products, significant technological developments, or unusual used market activity.

- INPUT has been forecasting detailed residual values for IBM and software-compatible mainframes since 1977 and for selected IBM peripheral products since 1979. The emphasis of the Residual Value Forecasting Series is analysis and anticipation of significant product development and pricing strategies rather than mere reporting of used market prices.

- IBM products covered in this report are the model series 3350 and 3380 disk drives, model series 3420 tape drives, and printer models 1403N1, 3211, and 3800. This report updates forecasts provided in a September 1982 report of the same title and a May 1982 report on IBM Multiplatter, Moving Head Disk Storage Systems. Other Residual Value Forecasting Series reports on IBM peripheral products that include a technology overview on peripheral categories include:

  - Residual Value Forecasts for IBM Disk, Tape, and Printer Systems (October 1981).

- Residual Value Forecasts for IBM Multiplatter, Moving Head Disk Storage Systems (June 1979, September 1980).

- Residual Value Forecasts for Printers (March 1980).

- Residual Value Forecasts for IBM 3420 Series Magnetic Tape Systems (April 1981).

- In the September 1982 report mentioned above, INPUT predicted that IBM would announce new printer and tape systems in the near future. In November 1982, IBM announced a new model of the 3800 high-speed printing system. This report will provide:

  - An in-depth description of trends in printing systems.

  - A review of printing products commonly found in large organizations.

  - INPUT's assessment of IBM's strategy with printing systems. (The announcement of the new tape systems is projected for later this year.)

- INPUT has just published a major study on optical storage systems (Impact of Upcoming Optical Memory Systems, April 1982) that discusses their potential effect not only on disk and tape storage systems but also on high-speed printers. Preliminary analysis of the long-range implications of this new technology is presented in Chapter II of this residual value report, along with the detailed analysis of printing systems.

- Chapter III provides residual value forecasts of the selected IBM peripherals, as well as the important considerations in developing such forecasts. Recent used market activity is also reviewed.

II A REVIEW OF DEVELOPMENTS AND DIRECTIONS IN DISK, TAPE, AND PRINTER TECHNOLOGY

A. DISKS

- INPUT's last residual value report on peripherals (September 1982) contained a comprehensive review of IBM's disk product generations and their characteristics. Based on a consistent pattern of announcement of new disk product generations at five-year intervals, it was predicted that IBM's next major disk product would be announced in 1985. Even though a substantial slip had occurred in first shipment of 3380s, it was felt that product design and prototype development of the 3380 follow-on generation was well underway, and the traditional five-year announcement cycle would be maintained.

- This judgment seems confirmed by mid-life purchase price reductions on 3380s despite the average slippage in delivery schedules of approximately 14 months. Purchase of 3380 disk drives and 3880 disk controllers was practically mandated by the nature of price changes that came at the end of 1982.

  - Purchase prices of the 3380 and 3880 were slashed by 15% and, in addition, a volume discount program was announced which offers users discounts ranging between 6% and 12%.

  - At the same time, rent and lease prices were raised by 15%, and long-term leases were made available through the IBM Credit Corporation.

- The net effect is to make purchase very attractive and short-term arrangements quite expensive (especially if the price increases for rentals and leases were based on past inflation rates).

- Therefore, INPUT still projects that a new disk product generation will be announced in 1985 and that it will incorporate the following major improvements:

  - Thinner coating on the base platter.

  - Substitution of a magnetic particle with greater field strength than iron oxide.

  - Increase in rotational speed from 3,600 revolutions per minute (rpm) to 6,000 rpm.

- However, careful analysis of optical disk technology has prompted a general review of potential impact on IBM disk product direction. This analysis will be presented later in this chapter.

B. TAPES

- IBM's direction in magnetic tape development was thoroughly reviewed in the September 1982 residual value report. At that time it was projected that a new tape product generation would be announced in the near future. It is still predicted that this will occur in 1983. A summary of the characteristics of this new product line includes:

  - One-half inch tape housed in a small square cartridge, which will probably use chromium dioxide rather than iron oxide as the magnetic material.

- Data transfer rates will be up to three megabytes per second.

- Both start/stop and streaming modes will be available.

- It will provide for common use of the 3880 controllers currently used for 3380 disks.

- When DiscoVision (the IBM-MCA joint venture established to develop a video-disk product) failed in 1982, many of the former IBM engineering personnel were offered reemployment in IBM's Tucson, Arizona, development center. This center is responsible for magnetic tape development activities. (The potential impact of optical media on magnetic tape development will be analyzed later in this chapter).

C. PRINTERS

- This section describes trends in printing systems, reviews some of the products commonly found in large organizations, and presents INPUT's assessment of IBM directions with printing systems.

- IBM printing systems for large data processing sites have evolved rather slowly and have not provided the price/performance improvement apparent in other peripheral categories. The three IBM high-speed printing systems in use today are the 1403 (announced in 1964), the 3211 (announced in 1969), and the 3800 (announced in 1975). IBM recently (November 1982) announced a new model of the 3800 that offers significant enhancements. This new model, the Model 3, is reviewed later in this section. IBM's general strategy in high-speed printing systems has been to improve functionality in new product generations while maintaining a relatively constant cost per unit of printed output. Said another way, IBM believes customers will buy new printer gener-

ations to obtain better quality output more rapidly at the same effective cost per unit printed.

- There are a number of trends evident in the evolution of printing systems. These trends reflect the growing direct use of computer tools by clerical and management personnel within organizations and the accelerating computerization of traditional publishing functions. Management wants printed output that is legible and attractively formatted. More and more written material is entered into computers where word processing software allows easy revision and rapid on-demand printing. The computerization of publishing functions such as typesetting and page makeup now permits knowledgable authors or their support personnel in computer laboratories and some computer centers to compose and print typeset documents. As these capabilities become more "user friendly," the demand for computer printers supporting a large assortment of type fonts and character sizes will increase substantially.

- Some of the more important trends influencing computer printer evolution are:

  - Improved character clarity. With nonimpact printers this is a function of the number of image-forming dots per character cell and, to a lesser extent, how the dots are applied to the paper. Dot density is normally specified as dots per square inch. IBM increased the dot density in the Model 3 version of the 3800 printer to 240 by 240 dots per square inch (from 180 by 144 in the Model 1). The Xerox 9700 printer is 300 by 300. At about 500 by 500 dots per square inch, the printed characters are equivalent in image quality to those produced on a selectric typewriter.

  - Graphics support. The ability to print both text and pictures is a requirement for many documents. Xerox has introduced a graphics option for the 9700 printer, and the IBM 3800 Model 3 will have a graphics capability when software support for its All-Points-

Addressable mode becomes available. A special form of graphics is digitized forms overlay. This feature permits storing electronically a bit-map of a frequently used form (e.g., a utility company's monthly invoice) to which variable information (the month's charges) is merged at time of printing (to produce the final invoice sent to the customer).

- Distributed printing. The ability to bring the printing device close to the document creator makes the production process much more efficient and encourages doing even short simple documents on the computer-based system. Much of the appeal of standalone word processing systems stems from their localized printing capabilities. Frequently the communications option for word processors is added to permit local printing of information stored or sent from other systems through a central host. Low-cost, nonimpact printers based on solid-state laser or ink-jet technologies are starting to emerge. Using a standard RS232 connection to an unconditioned phone line, they can quietly print 10 to 12 pages a minute using various type fonts supplied by the host computer.

- Compability. New generation printing systems should be able to print previously created documents (i.e., backward compatability) and should be able to print documents printable on other output devices - at least from the same vendor (i.e., product line compatability). Both IBM and Xerox are developing a "device independent" file protocol that will allow printing such files on any device for which a device driver exists (software explaining the device characteristics to the host computer). IBM calls their approach "Composed Page Data Set" facility and Xerox calls theirs "InterPress." Both support graphics, and if the printing device cannot create pictures, blank lines are inserted where the picture would otherwise appear.

- Color. The demand for color printing is not great. This will change when color is a common feature on display terminals, something which

is not expected to evolve for some time. IBM is developing a color ink-jet printer that will appear as a product when sufficient market demand exists. IBM is interested in ink-jet technology because of the low noise levels inherent with it and because low-cost office printers are possible. Office environments, a major target for future IBM products, are sensitive to both issues.

- IBM printer products common in most large organizations are the 3211 line printer, the 3800 Model 1 page printer, and the 6670 laser printer/copier. Two new products are the 3800 Model 3 and the Scanmaster. A product that is expected to be announced in the near future is the Electro Erosion printer.

- The 3800 Model 3 is IBM's reaction to their most serious competitor in the high-volume page printer market, the Xerox 9700. The Model 3 has two modes:

  - In "compatability mode" existing files can be printed with modest change. The 20 character sets normally provided with the 3800 are supplied in 240 by 240 dot density. To these initial 20 character sets IBM has added 39 additional ones at the new density. User-created character sets must be converted using a for-fee conversion aid. IBM states that throughput for the Model 3 should be equivalent to the Model 1.

  - In "All-Points-Addressable mode" the 3800 can print pictures and digitized forms overlays. To print large pictures, additional memory is required in the 3800, at additional cost. Large pictures are defined as over four square inches. The software support that allows printing of pictures has not yet been announced. To quote from IBM's product announcement, "IBM's direction is to provide support for the 3800 Model 3's new printing functions in some future releases on MVS System Products and licensed programs, including Document Composition Facility." There is no estimated date when this will happen.

INPUT projects it will be sometime in 1984 before this capability is really usable. In the meantime, they have countered somewhat the availability of the graphics option on the Xerox 9700.

- The 9700 still provides some features not available with the Model 3. The duplex option (two-sided printing) and computer output microfilm option are available for the 9700 and not the Model 3. The higher dot density of the 9700 and use of cut sheet paper produce better looking reports. The cut sheet paper does generate greater output dispatching overhead, however, and paper suppliers are now selling a continuous form "invisible" perforated paper that approaches the appearance of cut sheet paper (the samples INPUT has seen have an "invisible" side perforation; however, the top and bottom edges of the paper have quite visible tufts denoting a continuous form).

- The recently announced IBM Scanmaster digitizes information on paper documents. Once the image is digitized it can be directly routed to one or more remote Scanmasters or can be stored on a host computer. The device is a clever extension of point-to-point facsimile machines. The unit can also be used as a convenience copier or as a remote printer, although the relatively poor image quality and coated paper make such use unlikely where other alternatives are available. The importance of the Scanmaster is that it provides the basis for a rudimentary electronic filing and routing system for paper documents with images.

- A product IBM is expected to announce in the near future is a printing system developed in Europe and displayed last summer at a graphic arts exposition. It uses an electro-erosion technique to produce typeset quality masters for printing press reproduction. An array of 32 electrodes sweep across aluminum-coated black paper, firing (and thus evaporating the aluminum) when a black dot is required in forming the character image. The dot density is 600 by 600 per square inch, producing very sharp character definition at a cost of a few cents per page. The device can be directly driven by a host computer and creates typeset quality masters without chemical processing.

As with the 3800 Model 3 All-Points-Addressable mode, the underlying software is not yet ready for end-user production applications.

- Xerox is well positioned in the printing systems market with a series of largely compatible products ranging from the low-end, 12-page/minute 2700 to the high-end, 120-page/minute 9700. Their current focus is on strengthening the software base - to allow the merging of text and images (their Graphics Option) and in implementing a standard printer control language (called InterPRESS). The 2700 is becoming a strong contender in the OEM shared-logic word processing market. Both Wang and NBI have announced products using the 2700, and several other word processing companies will do so in the near future. The current line - 2700, 5700, 8700, and 9700 - obviously has placeholders, e.g., 1700, 3700, etc. Those could be filled as market requirements dictate.

- Perhaps a harbinger of future distributed office printers is the product Exxon displayed at the February Office Automation Conference in Philadelphia. The Exxon 965 is an ink-jet printer smaller than a daisy wheel printer with a single quantity OEM price near $6000. It has 480 by 224 dot density, is exceptionally quiet, and can store up to eight 96-character fonts. They expect to support downline-loaded fonts from a host computer in the next software release.

- IBM's directions and intentions in the printing systems area are not complicated. They intend to market a spectrum of compatible printing engines that provide generalized distributed printing in office environments and high-volume or specialized capabilities in centralized facilities. Their recently announced Document Interchange Architecture (DIA) and Document Content Architecture (DCA) provide a framework. The Composed Page Data Set facility defines file formats for merging text and graphics and creates a device independent file that, with the appropriate device driver, will permit printing on almost any IBM printer product.

- The pieces IBM needs to complete its coverage of the printing market are:

  - A high-resolution scanning device to digitize images for transfer to a host and then subsequent blending into combined text/graphics documents. An extension of the Scanmaster technology could provide this capability.

  - A low-cost quiet printer for the office environment that can support various type fonts and character sizes and, as an option, support color printing. The ink-jet printer under development in IBM research laboratories will fill this need.

  - A printing system that can produce camera-ready masters with typesetter quality. This would be final copy for documents ranging from brochures to books, where various type fonts, type sizes, and elaborate formatting would be molded together of produce high quality "beautiful" documents for press reproduction. Extensions to the electro-erosion technology could provide this capability.

- The ability to upgrade a 3800 Model I to a Model 3 in the field was a significant mid-life extender to this product. IBM printer products have traditionally maintained high residual values much longer than other peripheral product lines. The 3800 now seems destined to follow that tradition. This is because printers have not experienced the price erosion resulting from improved price/performance of newer generations and because the pace of technological advancement has not been as great as with other product lines.

D. OPTICAL DISK STORAGE SYSTEMS

- In the September 1982 report, Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, INPUT predicted that "optical disk products used for read-only archival document storage will appear in 1983 and will be in widespread use by 1984." Since that time, a comprehensive INPUT study of optical memory technology has been completed, and the results have been published in Impact of Upcoming Optical Disk Storage Systems, April 1982.

- The research provided important insights into the potential systems implications of optical disk products. Optical memory technology has capacity and cost characteristics that will eventually result in major changes in the way all information is stored and communicated. The potential impact extends not only to current magnetic storage systems, such as tape and disk, but to micrographics storage systems, traditional paper filing systems, and libraries. (The impact on libraries implies that "electronic publishing" will become fairly common.)

- A few examples of capacity will indicate why there is so much excitement about the technology:

  - A single side of an optical disk platter currently has more storage capacity than an IBM 3380 disk drive, and it has been projected that a double-sided platter will be able to store more than 10 times the capacity of a 3380 disk drive.

  - Such a double-sided optical disk platter is roughly equivalent to the entire Encyclopedia Brittanica (including illustrations).

  - A proposed optical disk pack would store approximately one-fourth the capacity of an IBM 3850 Mass Storage System in portable form.

- A projected "juke box" arrangement of 1,000 optical disks would provide a storage system requiring approximately 225 square feet of floor space and would be capable of storing the equivalent of:

  . Two million reels of magnetic tape.

  . Ten thousand IBM 3380 disk drives.

  . Twenty-seven IBM 3850 Mass Storage Systems.

  . All the documents in the National Archives of the United States.

- The cost of optical disk systems is projected to be less than one-tenth the cost of magnetic disk systems and indeed will be substantially less than the cost of maintaining a typical paper filing system, as shown in Exhibit II-1.

  - The costs for optical disk and the 3850 are for storing a digital representative of a page image at 200,000-500,000 bits per page.

  - The costs for paper files represent the costs of maintaining a paper filing system, the range resulting from differences in paper costs.

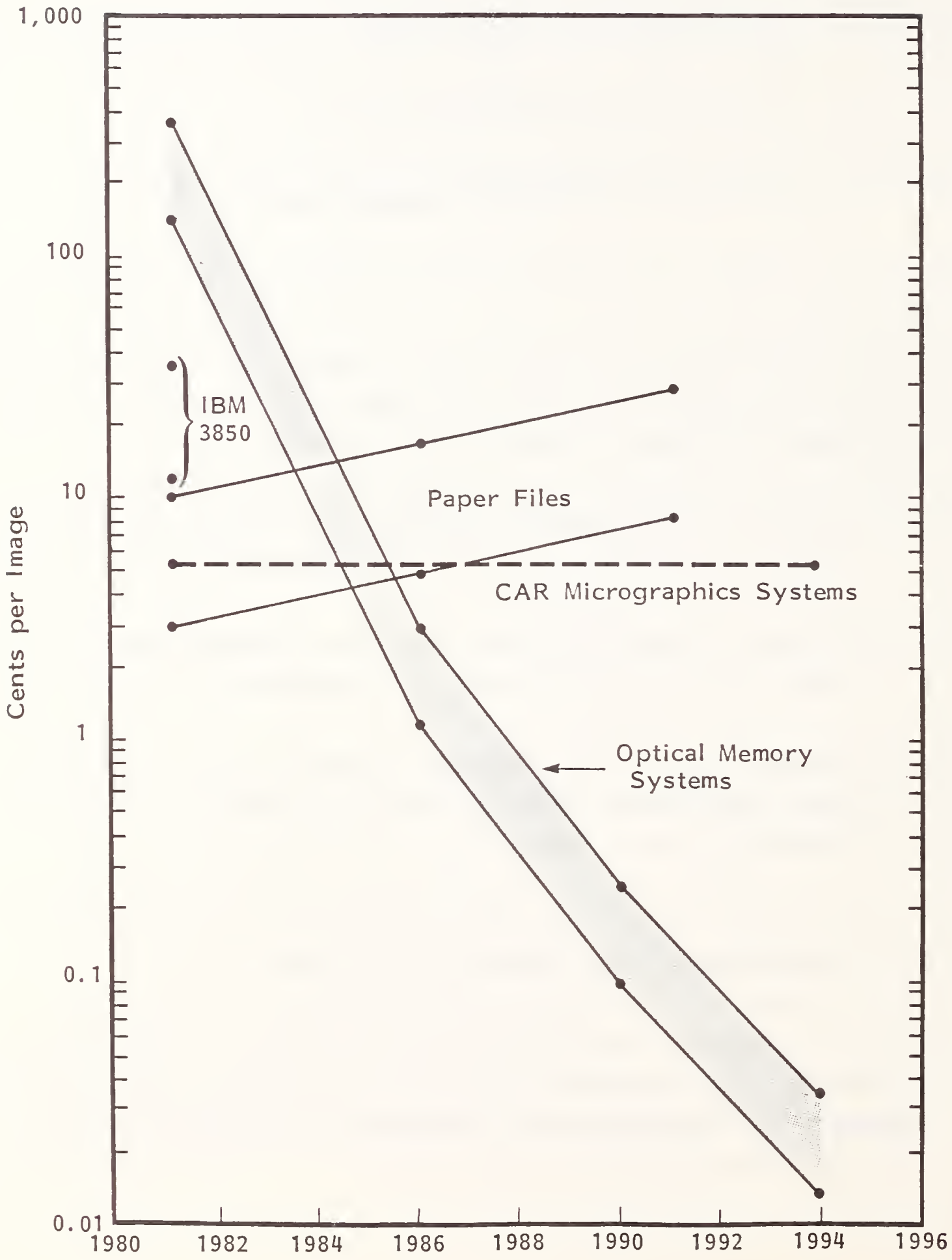
  - The computer-aided retrieval (CAR) micrographics system was used to permit realistic comparison with the on-line capability of the optical disk systems.

  - The cost per image for storage on an IBM 3380 disk drive (not shown) would be approximately 10 times that of the 3850.

- With such capacity and cost characteristics, it is obvious that optical disks will eventually have a significant impact on current storage systems. But there are other characteristics that complicate the determination of how soon this impact will occur. A brief summary follows:

EXHIBIT II-1

PROJECTED COSTS OF IMAGE STORAGE SYSTEMS



- Optical disks are removable and have been projected to have longer archival life than magnetic media; these are advantages above and beyond capacity and price.

- At present, commercially available optical disk products require interim processing (video tape for mastering) in order to get information on the disk. This represents a severe limitation in the applications which are currently suitable.

- Error rates are currently substantially higher than on magnetic disk.

- Current optical media is essentially "write once-read only."

- Basic research in media and laser technology are still without clear-cut direction, and product development is somewhat unpredictable because of a cloak of secrecy which most vendors have thrown over specific announcement plans.

• Despite the complexity of the current state of both research and product development, INPUT has reached the following conclusions:

  - Document storage systems employing enhanced versions of commercially available videodisk systems (originally designed for the consumer market) will be announced by a number of vendors throughout 1983. Experimental use of such systems will grow rapidly during 1984.

  - A number of single-platter optical disk drives with direct-read-after-write (DRAW) capability will be announced during the 1983-84 timeframe. These products will generally have the following characteristics:

. DRAW capability will permit software error correction, which will make the devices suitable for storage of images and encoded data.

. While most of the drives will be directed toward the office environment, STC will announce a product that will run off its magnetic disk controller and will be supported on IBM mainframes under MVS.

. The office-oriented drives announced will require six months to one year from date of announcement before they appear in office systems as electronic filing systems and certainly before they are integrated (in even a loose sense) with conventional data bases stored on magnetic disk.

. The media employed will not be erasable and therefore will be suitable only for read-only applications.

- Erasable media will become available in the mid to late 1980s, but optical disk will not be widely accepted as a direct replacement for magnetic disk in this decade. This will be true primarily because of IBM's magnetic storage strategy and its important role in providing an increasing proportion of IBM's revenue growth.

- IBM's strategy is to maintain magnetic disk as the primary mass storage medium into the 1990s, and it is INPUT's opinion that it will be largely successful. There will be certain IBM activities in the optical disk area, however:

  - Expect announcements of optical disk systems where they do not directly compete with mainframe storage (or current IBM products) during the 1980s.

  - IBM would prefer to see optical disk as a replacement for micrographics systems, and they will probably employ the technology for distribution of technical documentation of hardware and software systems and for educational materials.

  - Embedded optical storage in certain office systems is probable, especially in systems designed to replace paper files. (However, look for extensive staging to magnetic media for access.)

- It is also probable that IBM will not be able to completely forestall the acceptance of optical disk as a complement and supplement for magnetic storage media. Announcement of DRAW, read-only optical storage for mainframes, can be expected in the 1986-87 timeframe, and it is even possible that erasable media will be announced as early as 1989. However, actual use of optical disk systems may be limited due to the level of software support (just as 3800 Model 3 new printing functions have not been supported).

- The types of applications of optical disk systems that could impact use of the current IBM peripherals covered in this report are as follows:

  - Magnetic tape usage is especially vulnerable to impact by optical disk systems for the following reasons:

    - Users surveyed rated optical disk most attractive for the type of archival (or off-line) storage customarily associated with backup of magnetic disk files.

    - Problems of erasability are negligible since an optical platter costing between $10 to $100 is a throwaway item regardless of length of retention, especially when it is considered that the capacity of a single optical disk is equivalent to 200 magnetic tapes.

- Archival life of optical disk is estimated to be approximately five times that of magnetic tape.

- Collection of voluminous data (especially from satellites) presents an enormous handling problem when tape is used for temporary storage while awaiting data reduction. Optical disk would seem to be ideally suited for such large data collection problems.

- Magnetic disk will be subject to impact for the following reasons:

  - Because high density magnetic disks such as those on the 3380 are not removable, it is extremely expensive to have on-line access to infrequently used historical (or high-volume reference) information. Such information does not require updating, and optical disk will be an extremely attractive alternative for such on-line storage.

  - Users surveyed in the past indicate that a significant amount of on-line data does not require updating.

  - In addition, there are a number of applications that are restricted in their use because on-line magnetic disk storage remains too expensive. A specific example is electronic storage of images where 200,000-500,000 bits may be required for a single-page image. Storage and retrieval of digitized documents using magnetic disk will be quite expensive when using the IBM Scanmaster, and this will tend to limit the applicability of the system. Optical disk would be much more cost effective and could open up entirely new applications when used to supplement magnetic disk in Scanmaster types of applications.

- High-speed printers such as the IBM 3800 are frequently used to print multiple copies of large reference reports for multipoint distribution. The paper and distribution costs alone will justify optical disk without even considering the ease of access benefits of on-line information versus paper copies and the relative costs of storage space. The true cost of printing, including handling and storage of paper copies, is enormous - optical disk with easy access and demand printing should be very attractive.

- There is no question that optical storage technology will eventually have enormous impact on the residual values of magnetic tape, magnetic disk, and high-speed printer systems. The only question appears to be when.

- Keep in mind that the early products will have an extremely short life because of unsettled technology and lack of standards. Any optical disk systems installed in the mid-1980s will have little residual value by the end of the decade.

- Optical technology will require continuous monitoring during the 1980s. INPUT intends to include periodic reviews for its clients.

III RESIDUAL VALUE FORECASTS FOR SELECTED IBM PERIPHERALS

- Although many factors are considered in forecasting future residual values, the most important are projected new product announcements, anticipated price changes, and availability of the equipment (either new from IBM or in the used market) at selected future times. New announcements in the area of peripherals have not been nearly so dynamic as they have in mainframe computers, and announced price/performance characteristics have been relatively predictable. A major technological breakthrough, such as optical disk storage systems, with potentially dramatic impact on the residual values of peripherals must be anticipated in the forecasting process.

- New product announcements set price/performance standards in outright cost per unit of performance delivered and also in operating costs for power, space, air conditioning, maintenance, and human operator attention. New products have traditionally offered greater functionality to encourage customer migration to the new technology. Since optical disk systems will offer substantial price/performance incentives, limited functionality (compared with competing products) will be used to discourage mass migration and to extend the effective life of current peripheral products.

- Exhibit III-1 presents a price trend history for the selected IBM peripherals included in this report. IBM alters prices to maximize revenue and to protect market share, and price changes can be either increases or decreases depending upon the objective. Since the last residual value report on peripherals was distributed in September 1982:

EXHIBIT III-1

PRICE TREND HISTORY FOR SELECTED IBM PERIPHERALS

TYPE OF EQUIPMENT	1964	1969-1971	1973-1975	1977-1979	1980-1981	1982	1983
Printers:							
1403N01	$ 39,965	$ 33,970	$ 38,140	$ 40,040	-	-	-
2821-2	27,100	23,040	25,900	27,190	-	-	-
3211	-	69,360	63,630	53,440	$ 40,080	-	-
3811	-	30,600	28,080	23,580	17,685	-	-
3800-001	-	-	310,000	341,750	358,800	$373,150	$315,000
Tapes:							
3420-003	-	13,580	12,420	14,340	-	14,910	-
3420-005	-	18,170	16,650	19,230	-	19,990	-
3420-007	-	22,380	20,520	21,540	-	22,400	-
3420-004	-	-	24,000	-	-	-	-
	-	-	21,960	23,050	18,440	19,170	-
3420-006	-	-	28,000	-	-	-	-
	-	-	25,650	26,130	21,540	22,390	-
3420-008	-	-	31,000	-	-	-	-
	-	-	28,440	29,860	23,890	24,840	-
Disks:							
3350-B02	-	-	49,500	31,680	-	32,940	-
3375	-	-	-	-	32,550	33,850	-
3380-B04	-	-	-	-	81,000	84,240	71,600

NOTE: Prices shown were the IBM list prices in effect at the end of the designated time period. The two figures shown for the 3420 models 4, 6, and 8 are the list prices announced in the period reported.

- Prices of tapes have not been changed.

- As reported earlier, prices for 3380 disks have been reduced by approximately 15%.

- The 3800-1 price was reduced with the announcement of the 3800-3, but still remains higher than it was at time of announcement in 1975.

- As can be seen, only disks have been reduced significantly over their typical five-year product life. The rapidly changing performance capabilities require recovering high development costs quickly, and thus early pricing is very high relative to manufacturing cost. This permits significant reductions when PCM competition appears or when a new generation announcement approaches.

- A major factor influencing residual values is projected price decreases on current equipment. Although IBM did reduce the price of the 3800 Model 1 from $373,150 to $315,000 upon announcing the Model 3, INPUT believes this is a unique situation. The intent of the price decline was to accelerate conversion to purchase of leased and rented units with substantial accrued purchase option credits, and to establish the Model 3 (also priced at $315,000) in a strong price position against competition.

- Another major factor is new equipment generations with significant price/performance improvements. INPUT does not expect to see a replacement for the 3800 family for several years. IBM will focus new product development into distributed printing systems for the office. In fact, if the potential impact of optical disk systems on high-speed print systems (which was described in the previous chapter) materializes, the 3800 could remain the primary IBM system for an extended period.

- Exhibit III-2 shows used market average retail values (as a percent of IBM list price) in January, April, July, and October 1982 and January 1983 for the disk,

EXHIBIT III-2

USED MARKET AVERAGE RETAIL VALUES FOR SELECTED IBM PERIPHERALS

MODEL	1981	1982				1983
	OCTOBER	JANUARY	APRIL	JULY	OCTOBER	JANUARY
3330-001	35%	33%	18%	10%	6%	3%
3330-011	52	44	38	23	7	4
3350-A02	140	95	73	65	59	52
3350-B02	140	95	73	65	60	53
3380-AA4	-	-	130	108	104	103
3380-B04	-	-	130	108	105	103
3420-003	35	26	19	11	9	8
3420-005	36	24	17	13	11	10
3420-007	44	35	29	23	18	13
3420-004	68	61	54	47	52	55
3420-006	70	66	66	64	62	54
3420-008	87	80	80	76	80	69
1403-N01	19	16	14	11	8	7
3211-001	59	59	55	55	55	50
3800-001	68	65	65	63	63	63

The values shown are used market retail values as a percent of IBM list price. At any given time, three price levels exist:

Retail Price - The amount an end user would pay for the equipment.

Dealer Price - The amount a dealer would pay another dealer to acquire equipment to complete a contracted sales obligation.

Wholesale Price - The amount a dealer would pay to acquire equipment for resale.

The dollar spread between levels is a function of the total value of the transaction. For peripherals equipment, the wholesale price will typically be 70% to 90% of the retail price.

tape, and printer products included in the report. Exhibit III-3 shows a direct comparison of January 1983 used market retail values against those projected in September 1982.

- The disk projections were extremely accurate, including the year-end price reductions of the 3380.

- The average retail prices for tape equipment in January 1983 were generally lower than those forecasted last September. This is probably the result of the still-to-be-announced new tape product that has been projected.

- Although they were lower, printer prices conformed quite closely to those projected - especially considering the list price reduction which occurred on the 3800 Model 1 at the time of the Model 3 announcement.

- Exhibit III-4 projects future average used market retail values at January 1, 1984 through 1988 for selected disk, tape, and printer products. Exhibits III-5 through III-15 graph these projected residual values as a percent of current IBM list price.

- The projected residual values for tape equipment have generally been lowered based on used market activity since the last report.

- The projected residual values for 3350 disks have been lowered, and those for 3380 have been increased based on the substantial list price adjustment to the 3380 (Exhibit III-1). However, this aggressive price adjustment results in the projected retail prices shown in Exhibit III-4 being lower than corresponding projections made in the September 1982 residual value report.

- The projected residual values of the 3800 Model 1 printer have been increased to reflect the extended life of the system, which is indicated by its upgrad-

EXHIBIT III-3

COMPARISON OF
USED MARKET AVERAGE RETAIL PRICES AGAINST PROJECTION
(January 1983 Against September 1982 Projections)

EQUIPMENT TYPE	MODEL NUMBER	AVERAGE RETAIL PRICE JANUARY 1983	JANUARY 1983 RETAIL PRICES PROJECTED SEPTEMBER 1982
Disk	3350 A02	$ 21,632	$ 21,600
	3350 B02	17,458	17,100
	3380 A04	88,899	86,300
	3380 B04	73,748	71,600
Tape*	3420-003	1,193	1,800
	3420-005	1,999	2,600
	3420-007	2,912	5,200
	3420-004	10,543	8,900
	3420-006	12,091	14,600
	3420-008	17,140	19,300
Printer	1403-N-1	2,306	3,000
	3211-001	16,925	19,200
	3800-001	198,450	216,400

* Prices listed include feature 6631 (1600 BPI Density) for Models 003, 005, and 007 and feature 6420 (6250 BPI Density) for Models 004, 006, and 008.

The dollar spread between retail ("buy") and wholesale ("sell") price levels depends upon the volume of the transaction. For the range of values shown above, the wholesale price will typically be 70% to 90% of the retail price.

EXHIBIT III-4

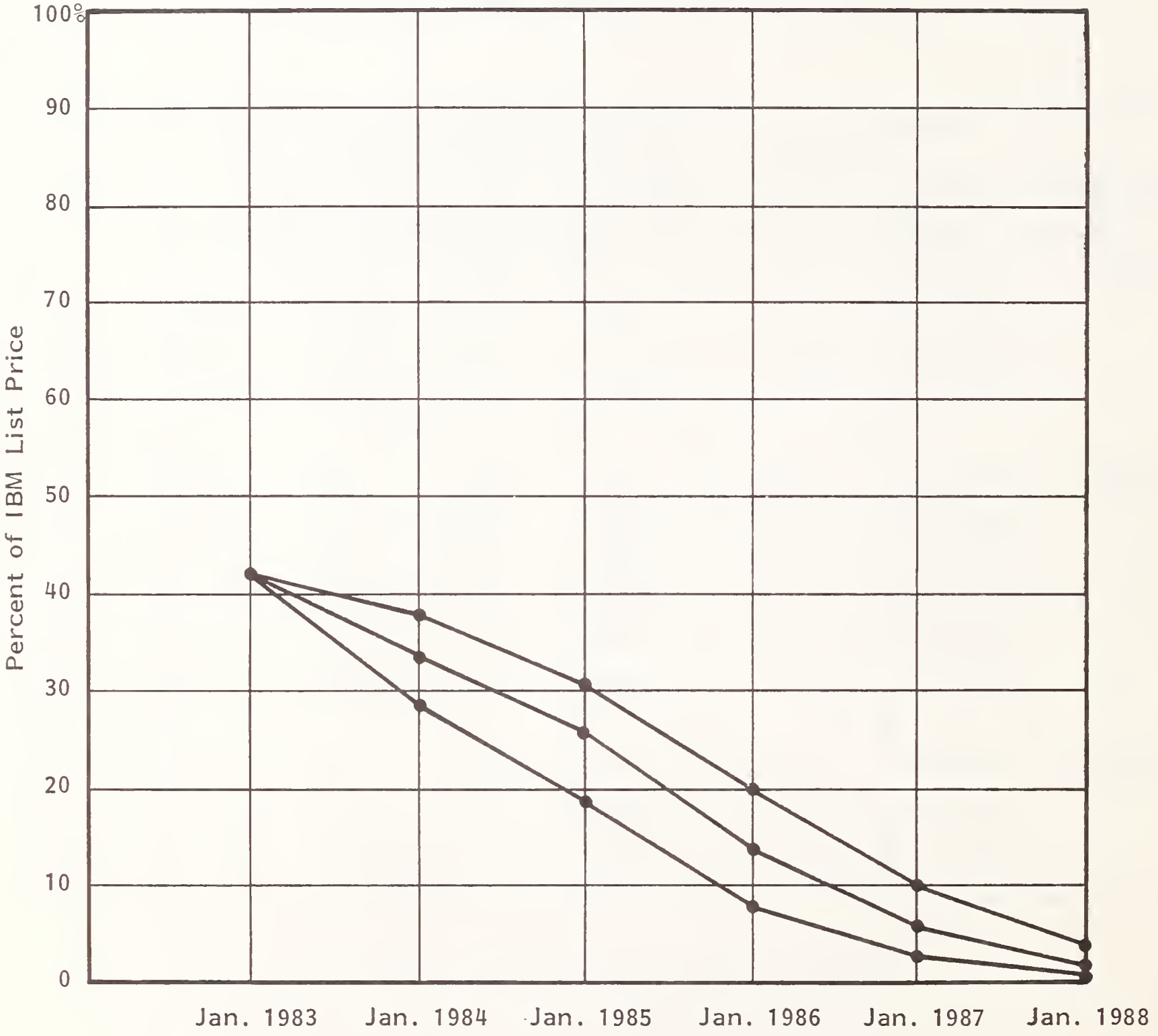
PROJECTED USED
RETAIL PRICES FOR SELECTED IBM PERIPHERALS

EQUIPMENT TYPE	MODEL NUMBER	CURRENT LIST 1/1/83	PROJECTED USED MARKET RETAIL VALUE AT JANUARY 1 OF:				
			1984	1985	1986	1987	1988
Disk	3350 A02	$ 41,600	$ 14,100	$ 10,800	$ 5,800	$ 2,500	$ 800
	3350 B02	32,940	11,200	8,600	4,600	2,000	700
	3380 A04	86,310	67,300	60,400	44,900	36,300	24,200
	3380 B04	71,600	55,800	50,100	37,200	30,100	20,000
Tape*	3420-003	18,495	900	600	400	200	-
	3420-005	23,575	1,900	1,400	900	500	200
	3420-007	25,985	2,300	1,800	1,300	500	300
	3420-004	21,170	6,800	5,300	4,200	1,700	600
	3420-006	24,390	7,300	5,400	3,700	1,200	500
	3420-008	26,840	11,300	8,900	6,400	3,200	1,900
Printer	1403-N-1	40,040	2,000	1,200	800	400	-
	3211-001	40,080	14,000	11,200	8,000	5,600	3,200
	3800-001	315,000	173,300	157,500	138,600	100,800	50,400

EXHIBIT III-5

PROJECTED RESIDUAL VALUES FOR THE

IBM 3350 DISK DRIVE

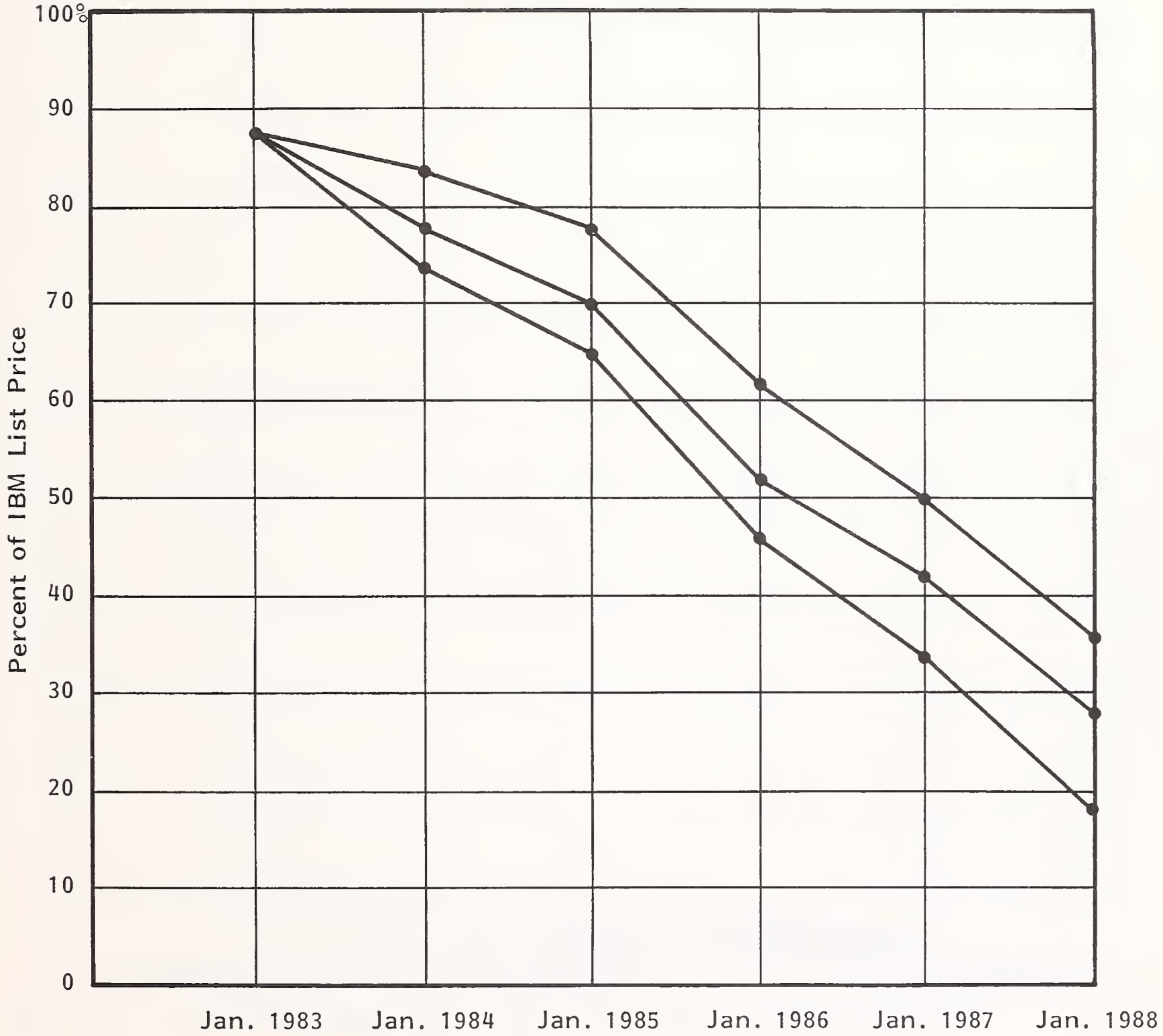


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	38	31	20	10	4
Expected	34	26	14	6	2
Low	29	19	8	3	1

EXHIBIT III-6

PROJECTED RESIDUAL VALUES FOR THE

IBM 3380 DISK DRIVE

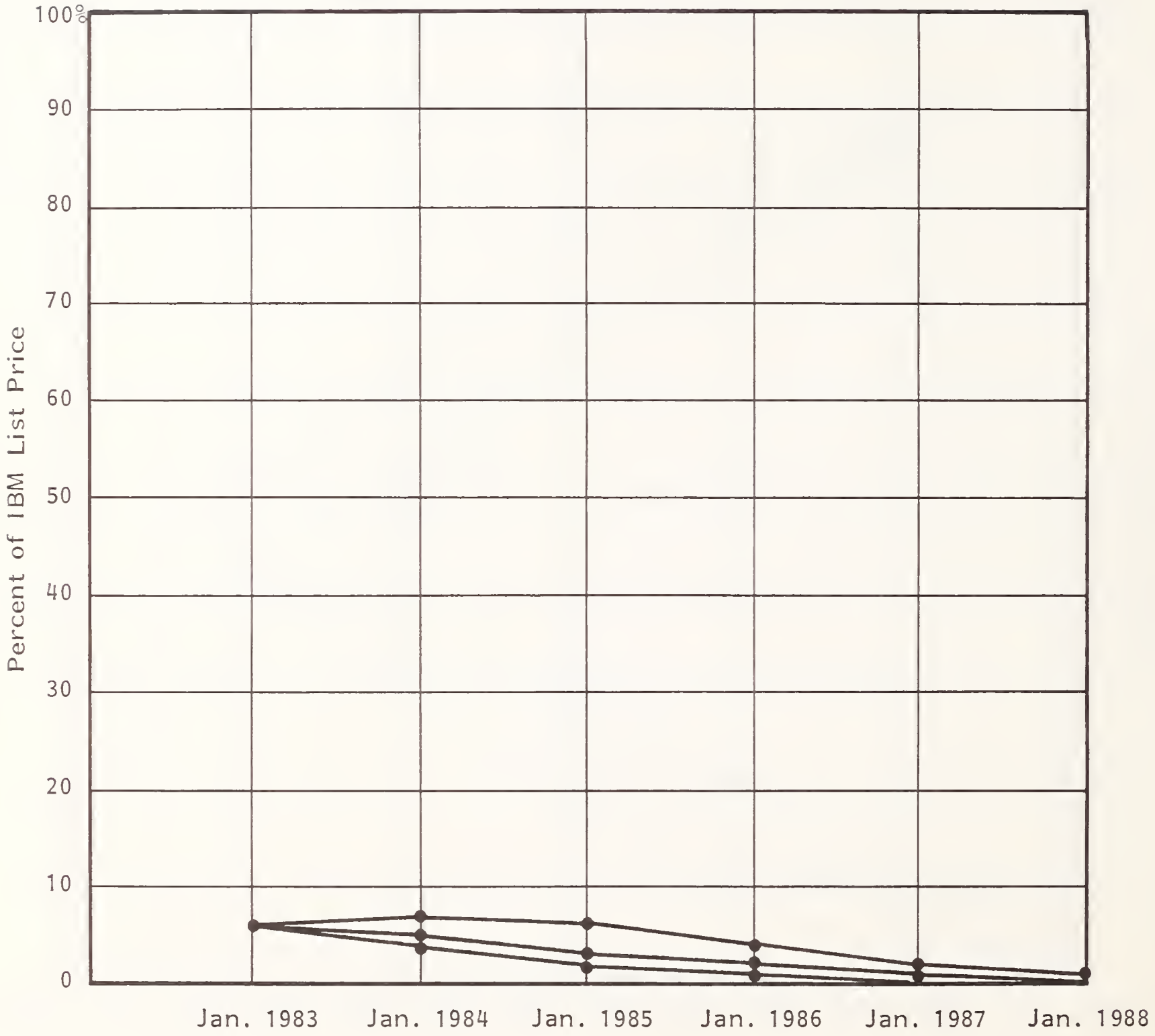


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	84	78	62	50	36
Expected	78	70	52	42	28
Low	74	65	46	34	18

EXHIBIT III-7

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-003 TAPE DRIVE

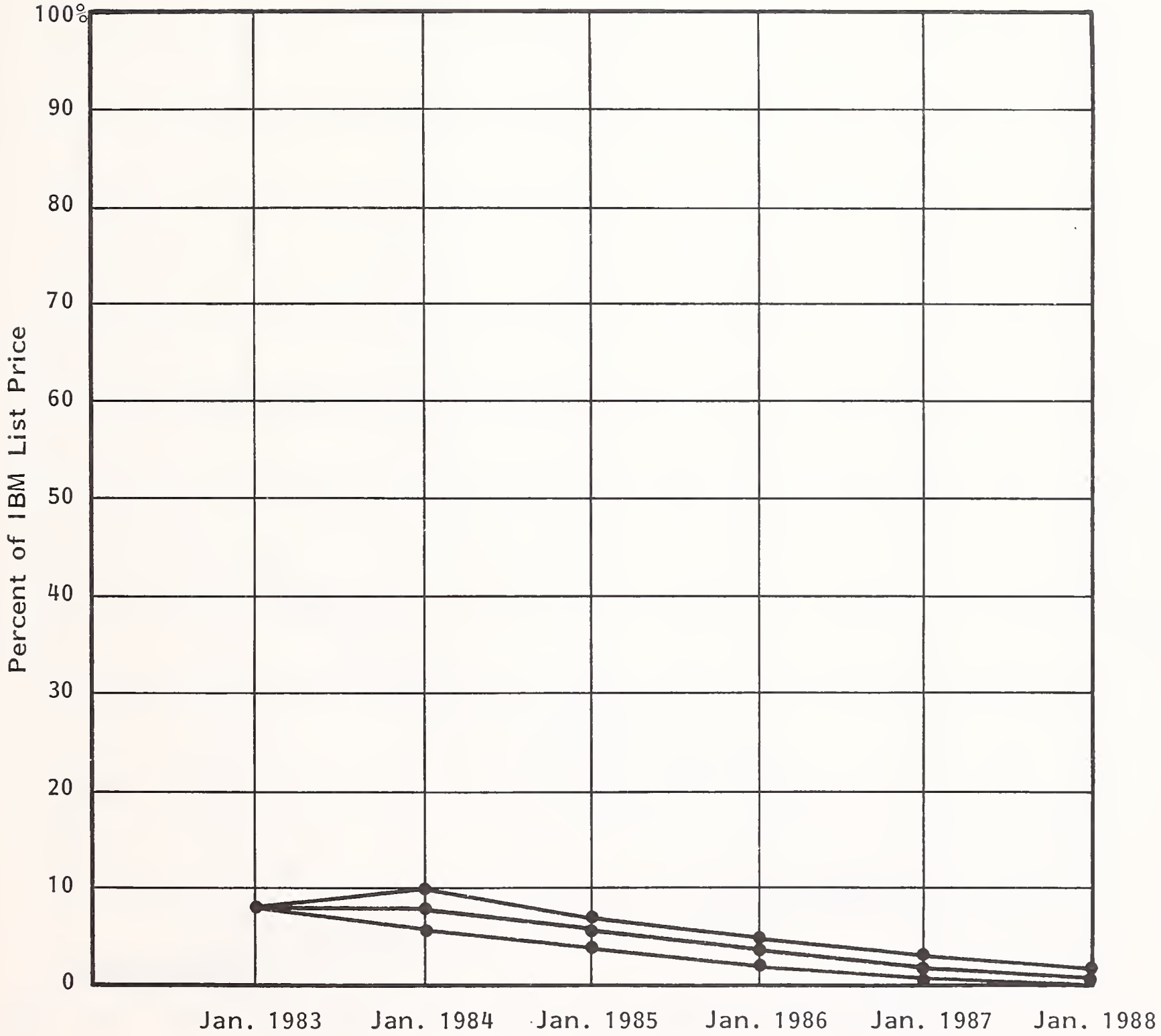


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	7	6	4	2	1
Expected	5	3	2	1	–
Low	4	2	1	–	–

EXHIBIT III-8

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-005 TAPE DRIVE

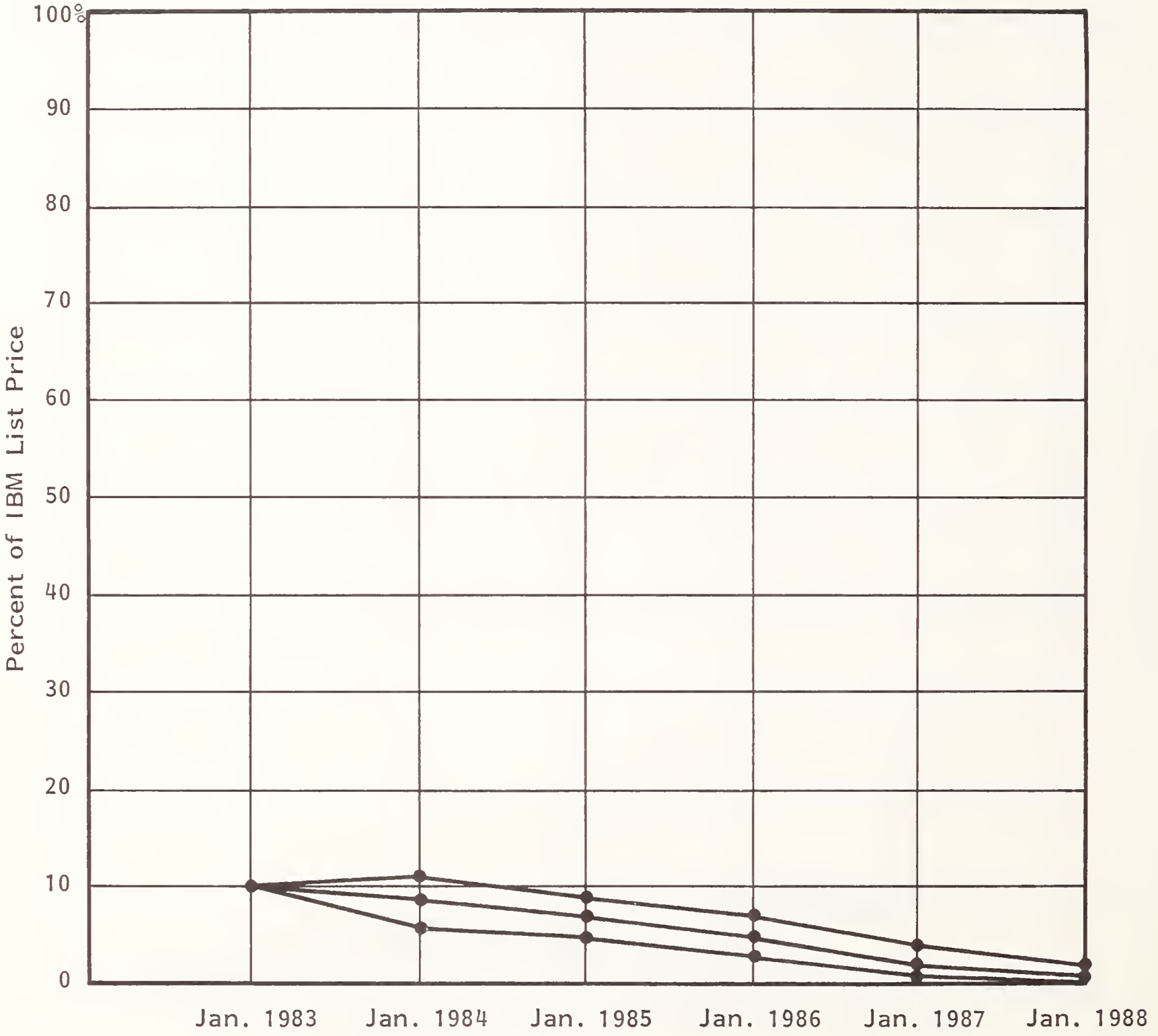


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	10	7	5	3	2
Expected	8	6	4	2	1
Low	6	4	2	1	–

EXHIBIT III-9

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-007 TAPE DRIVE

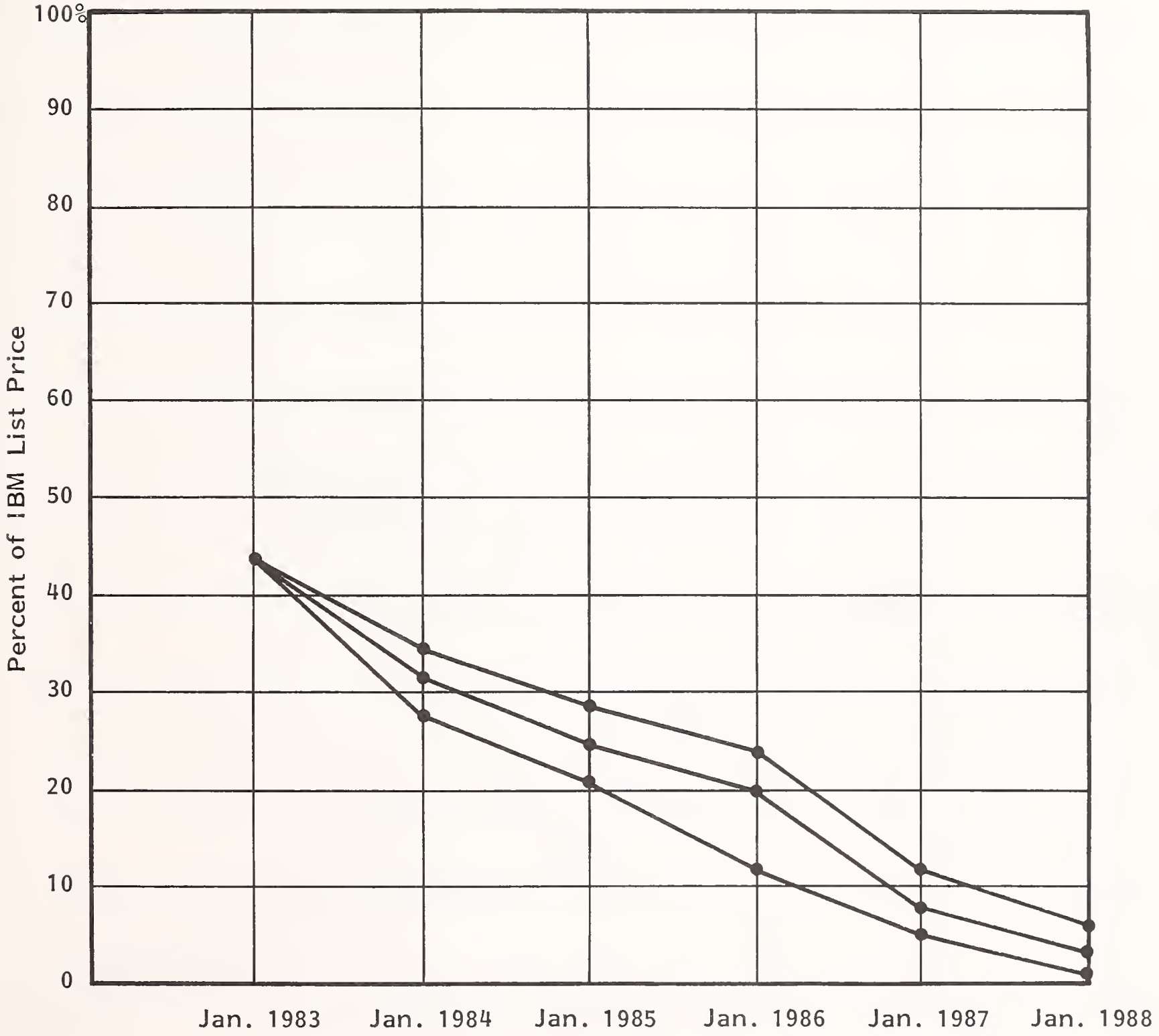


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	11	9	7	4	2
Expected	9	7	5	2	1
Low	6	5	3	1	–

EXHIBIT III-10

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-004 TAPE DRIVE

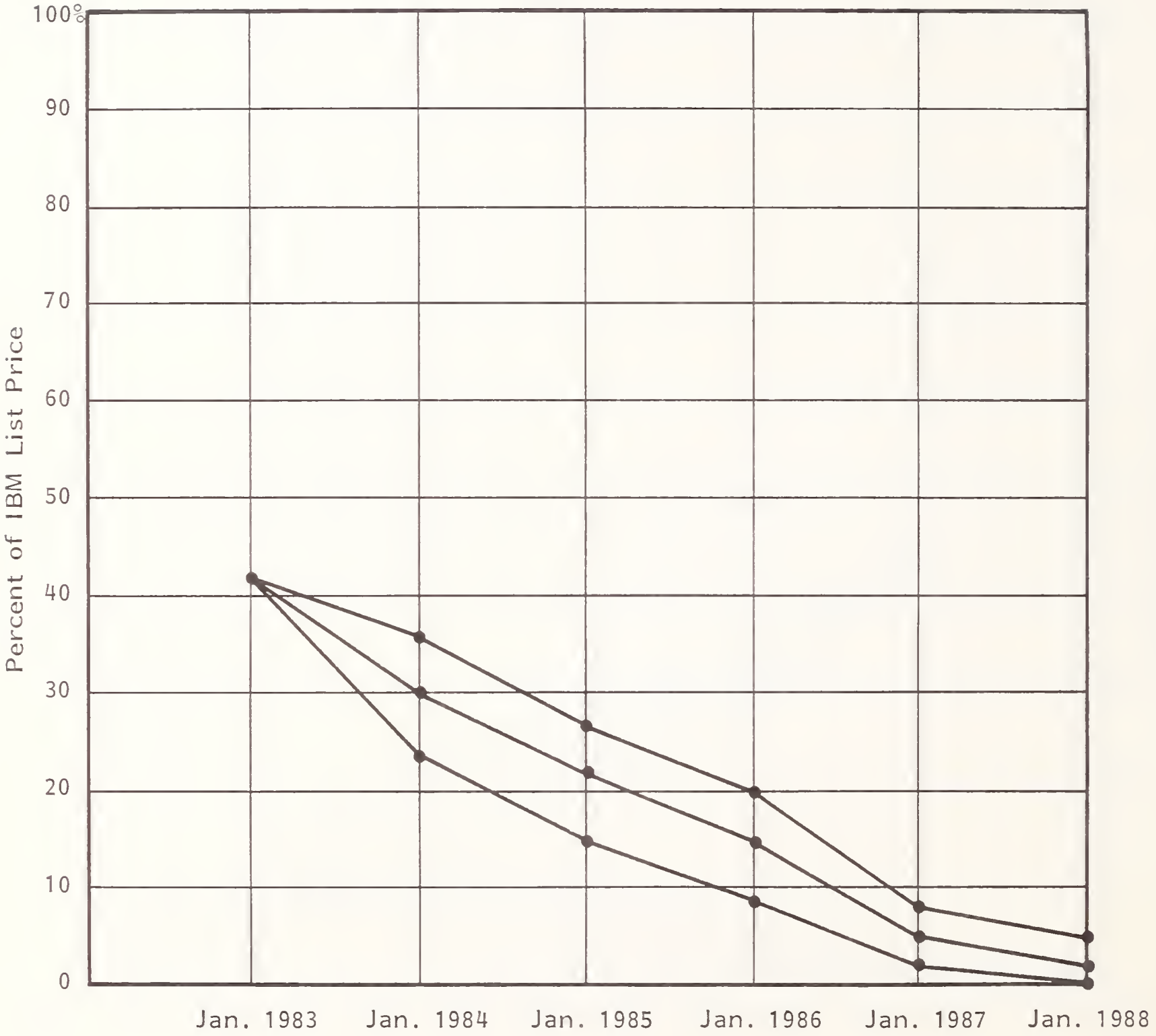


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	35	29	24	12	6
Expected	32	25	20	8	3
Low	28	21	12	5	1

EXHIBIT III-11

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-006 TAPE DRIVE

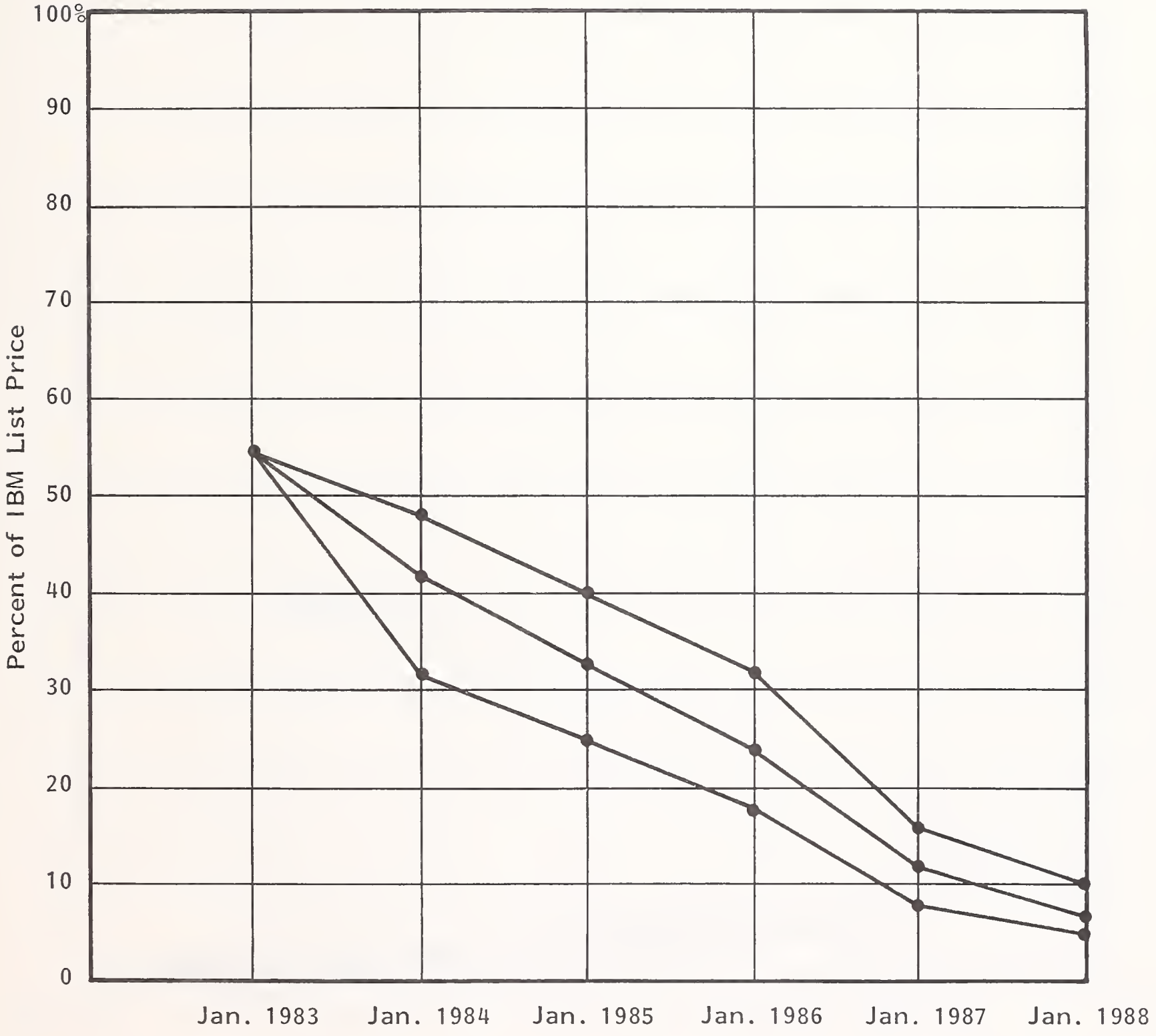


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	36	27	20	8	5
Expected	30	22	15	5	2
Low	24	15	9	2	1

EXHIBIT III-12

PROJECTED RESIDUAL VALUES FOR THE

IBM 3420-008 TAPE DRIVE

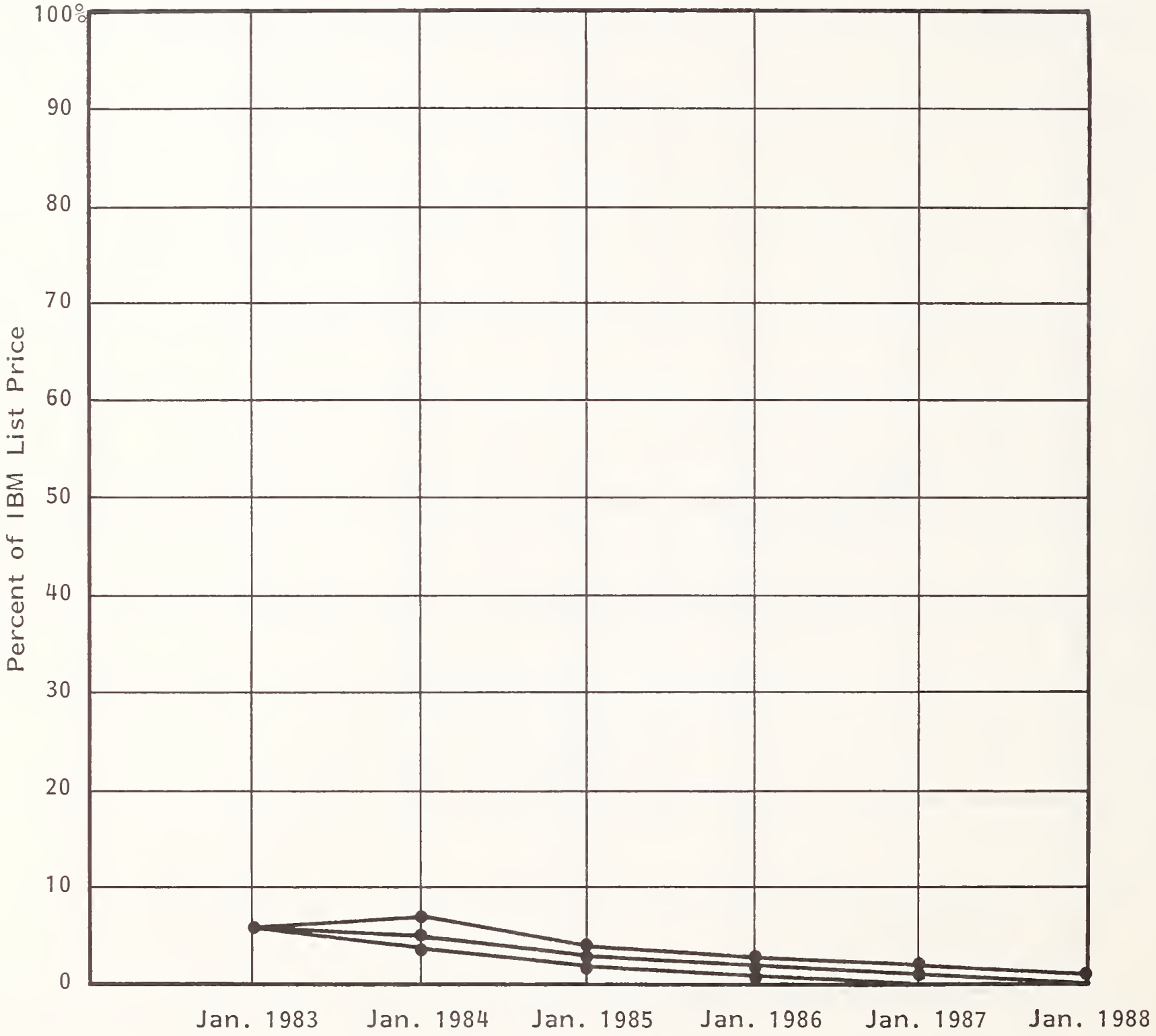


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	48	40	32	16	10
Expected	42	33	24	12	7
Low	32	25	18	8	5

EXHIBIT III-13

PROJECTED RESIDUAL VALUES FOR THE

IBM 1403 PRINTER

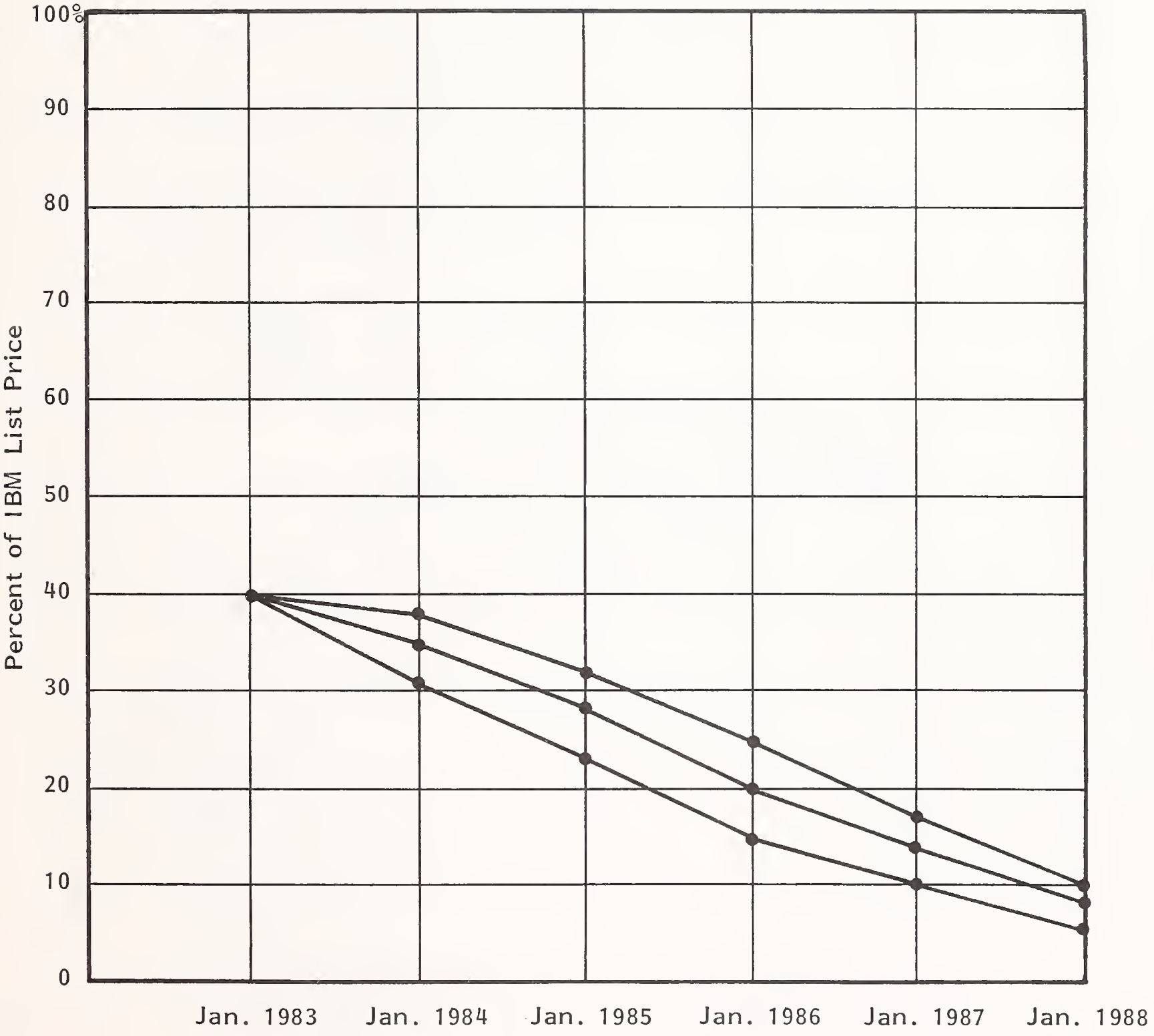


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	7	4	3	2	1
Expected	5	3	2	1	–
Low	4	2	1	–	–

EXHIBIT III-14

PROJECTED RESIDUAL VALUES FOR THE

IBM 3211 PRINTER

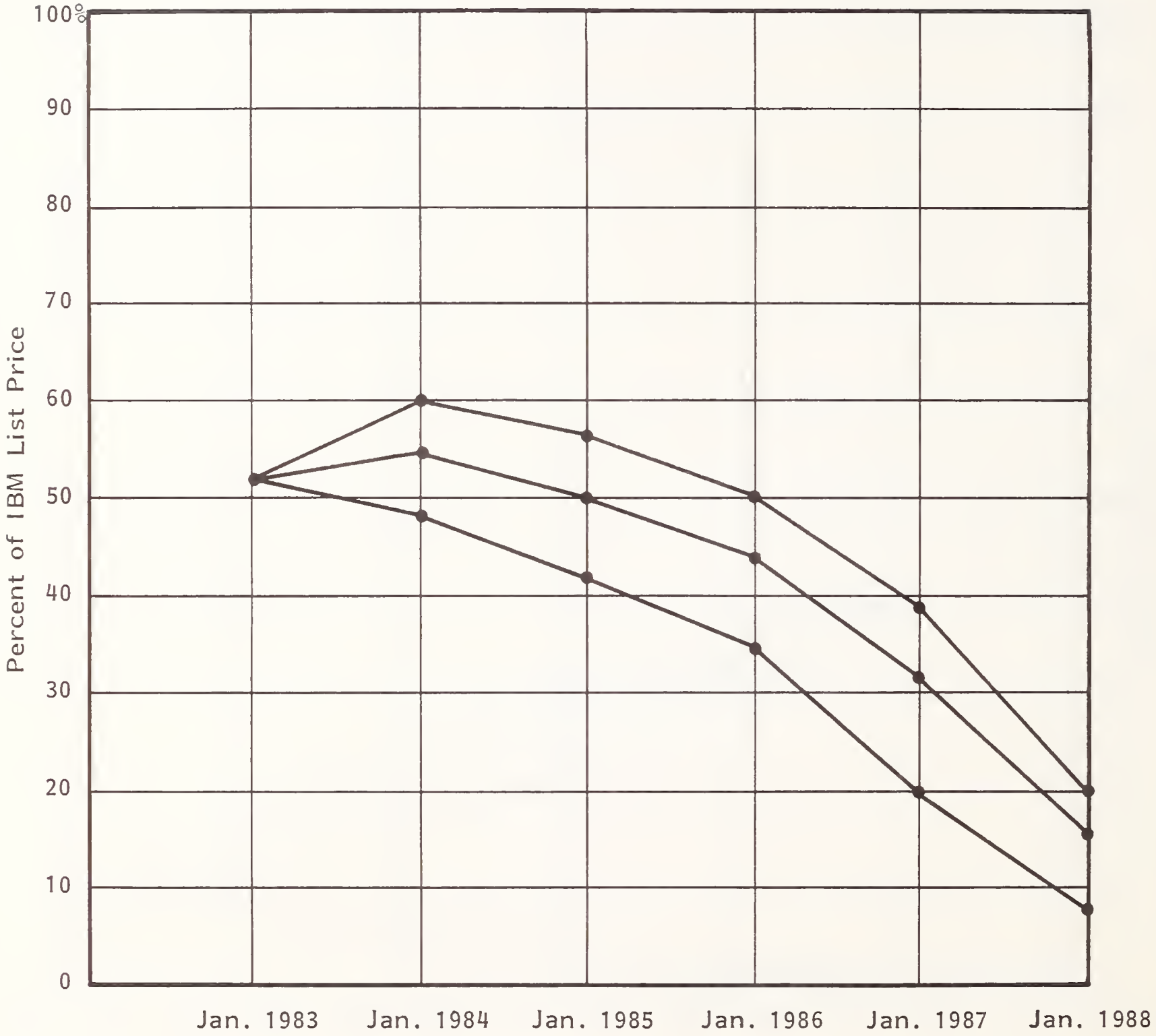


PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	38	32	25	17	10
Expected	35	28	20	14	8
Low	31	23	15	10	5

EXHIBIT III-15

PROJECTED RESIDUAL VALUES FOR THE

IBM 3800 PRINTER



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	60	57	50	39	20
Expected	55	50	44	32	16
Low	48	42	35	20	8

ability to the newly announced 3800 Model 3. This results in substantially higher projected retail prices for the 3800 Model 1 in the later years of forecast (Exhibit III-4) when compared with the September 1982 report.

- Exhibit III-16 provides current list prices for IBM disk products. Projections are not given in this report for all members of the IBM 3350 and 3380 families. INPUT predicts residual values for other members of a given product family to be proportional to the ratio of the respective list prices. For example, the forecast residual value of the 3350 A2 (list price $41,600) on January 1986 is $5,800. The forecast value at that same date for the 3350 C2F (list price $53,340) would be:

$$\frac{\$53,340}{\$41,600} \times 5,800 = \$7,437$$

EXHIBIT III-16

LIST PURCHASE PRICES FOR
IBM DISK PRODUCTS
(March 1983)

PRODUCT MODEL	PURCHASE PRICE (Dollars)
3330-1	$33,670
3333-1	42,200
3330-11	47,920
3333-11	56,450
3350-A2	41,600
3350-A2F	51,910
3350-B2	32,940
3350-B2F	43,250
3350-C2	43,030
3350-C2F	53,340
3370-A1	44,350
3370-B1	29,550
3375-A1	38,040
3375-B1	28,770
3375-D1	36,290
3380-A4	86,310
3380-AA4	98,640
3380-B4	71,600

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- Analysis of Software Maintenance Issues
- Review of Software Product Market Opportunities
- Analysis of Network User Requirements

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RESIDUAL VALUE FORECAST:

FALL UPDATE

NOVEMBER 1983

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INFORMATION SYSTEMS PROGRAM

RESIDUAL VALUE FORECAST:

FALL UPDATE

NOVEMBER 1983

RESIDUAL VALUE FORECAST: FALL UPDATE

CONTENTS

EXHIBITS

I INTRODUCTION

- This residual value report is produced as part of INPUT's Management Planning Program for Information Systems. Residual value projections in this series of reports are updated at least once each year for the systems covered. Normally, specific reports cover either IBM and software-compatible mainframes or disk, tape, and printer systems.

  - The last residual value forecast for large IBM and plug-compatible mainframes was published in December 1982.

  - The last residual value forecast for peripheral systems was published in March 1983. (See the appendix for these titles and other related INPUT reports.)

- This is the first annual update report designed to analyze significant announcements and technological trends that could affect residual values of both mainframes and peripherals. This conforms with INPUT's emphasis on analysis and technological forecasting rather than mere reporting about used market activity.

- Chapter II will review IBM's pricing strategy and how it has changed. The repercussions of this strategy for the used-computer industry (both vendor and customer) and for residual value accounting will be analyzed, and specific product price adjustments will be reviewed.

- Chapter III will update significant vendor announcements of mainframes, peripherals, and software that may impact residual values of the systems covered in the residual value report series. These announcements will be related to INPUT technological projections contained in prior residual value reports.

- Because of recent IBM price adjustments and mainframe announcements, Chapter IV will contain a general IBM mainframe strategy review. This review will be preliminary to the residual value forecast of IBM and plug-compatible mainframes that will be issued in December 1983.

- Chapter IV will present original residual value forecasts for the IBM 4331 and 4341 computer systems and will provide an analysis of the impact of recent price adjustments and product announcements on previously published residual value forecasts.

II REVIEW OF PRICE ADJUSTMENTS

A. CHANGES IN IBM STRATEGY

- Various "IBM-watchers" have recently observed that IBM product life cycles are getting shorter. This has been attributed both to IBM's philanthropic desire to bring the price/performance advantages of new technology to its customers, and to its predatory drive to kill off all competition. One has only to look at the history of the IBM 3705 communications controller to determine that neither technological philanthropy nor competitive predation lies behind product life cycles (and consequently pricing policies). It is something much simpler - profitability to IBM.

- Along these lines, the classic controversy about whether IBM is driven by technology (quality products), marketing, or manufacturing is really a moot question since IBM is above all a finance-driven company. Hot new technological products will not be released, salesmen will not maintain their life style, and factories will not be automated unless the products being released, sold, and manufactured meet IBM profit objectives. Customers can assume that any IBM price changes are intended to maximize profits and that any IBM product announcement is priced to meet profit objectives over the product's life cycle. It is wise to make these assumptions when making decisions concerning rental, lease, and purchase of IBM products.

- It is also wise to understand that IBM, leasing companies, financial institutions, and customers are all involved in a complex game in which price adjustments, product life cycles, and residual values are all related. In attempting to understand the game, it is important to review IBM's strategic shifts as the rules have evolved.

  - IBM is the world's most sophisticated leasing company; it had to be forced to sell its equipment (consent decree of 1956). IBM would be perfectly happy to assume all of the risk of managing a lease inventory of its entire product line if others couldn't purchase equipment - and you can be sure that product life cycles would not be as short as they are today. (Anyone who saw a 407 tabulator being used as a printer on a 709X computer in the early 1960s recognizes IBM's capacity to extract revenue from its equipment.)

  - It was approximately 20 years ago that a few IBM planners decided that the seven-year installed life of IBM mainframes coupled with the five-year writeoffs reflected in lease prices provided a business opportunity for those willing to accept "less-than-IBM margins." Some of them left and went into the leasing business. From IBM's point of view, leasing companies skimmed the cream from the end of the product life cycle when equipment had been written off but continued to produce revenue.

  - The entire computer leasing industry was founded on the premise that the IBM "profit cream" could be diluted and distributed to those who would be satisfied with milk (or even skim milk). Among the beneficiaries of this distribution would be:

    . The leasing companies who intended to extract the lease revenue from the anticipated "excess installed life."

    . The banks who would finance the purchase of the equipment.

. The customers who would benefit from lower lease prices.

- The game was really a simple accounting exercise from the perspective of all of the players except IBM, which immediately recognized that its strategic planning would be complicated by lease-purchase ratios, a substantial used-computer market, and a necessity for planning the obsolescence of products based on both of the preceding factors rather than on useful product life or technological competition.

- What was not so apparent to IBM (at that time) was that this strategy of complexity was ideally suited to their own position in the game - specifically, one with the information necessary to define and change the rules while the game was in progress.

- It is probable that the strategy, which was practically forced on IBM, also contributed the corporate battle cry for the 1970s and 1980s: "Information is a corporate asset and should be treated as such." This implies that computer-based systems to manage the corporate asset (information) are mandatory for an enterprise to compete successfully in today's changing marketplace. IBM proceeded to build the information systems that would permit it not only to compete, but to quite effectively control the revenue and profitability from its product line through its pricing strategies. Among the systems that were implemented are the following:

  - A planning data base that tracks every IBM box at a type, serial level from the time it is placed on order (and receives a temporary serial number) to the time it is scrapped.

  - A product measurement accounting system that permits analysis of revenue and profitability of all products (plan versus actual).

- A separate purchase system that provides special analyses to each product on a lease-versus-purchase basis (remember even purchased boxes can normally be tracked by IBM as they move through their life cycles).

- And, of course, historical analyses of the impact of price changes and product announcements are readily available.

- IBM has every right to regard information as a corporate asset - it is like playing poker and knowing where all the cards are - you may not always win, but you will certainly cut your losses and maximize your winnings.

B. INDUSTRY REPERCUSSIONS

- Armed with information not available to the others playing the game, IBM has become extremely adroit at using price changes, product announcements, and rumored product announcements to control its revenue flow and maximize profits. IBM has seldom had to apologize (as they did in the 1960s) for making too much money because of unusually high purchase activity (on System/360). And, if they need additional revenue, they can determine whether to lower purchase prices or raise lease prices based on fairly predictable results in the marketplace.

- A few years ago, at an INPUT conference, the vice president of a major investment banking firm stood up before our client base and stated: "Last year I asked you whether you were going to lease or purchase your equipment and you said 'lease.' What did you do - purchase! This year I am not going to ask you - you are going to do what IBM wants you to do." There is some truth in the above analysis, but it is also true that IBM price changes give some insight into what IBM is planning for the future. This limited information can be of benefit provided you understand the game that is being played (maximize IBM profit) and the fact that the dealer is playing with a loaded deck.

- IBM prices have traditionally provided the "umbrella" under which both competitive vendors and leasing companies must operate. Over the last decade, the direct price/performance comparisons made possible by plug-compatible vendors (and leasing companies) have forced IBM to apply continuing price/peformance pressure to maintain market share. In order to maintain profitability, while providing improved price/performance, it is essential to obsolete systems that enter the used market - hence the shorter product cycles (especially for mainframes).

- Pursuing its business objectives, IBM has established a pattern that resembles the classic year-end price reductions given when the automobile industry is making model changes. The idea is to offer a bargain on a particular model in order to clear inventory before the new ones appear. With IBM, it works out somewhat differently.

  - IBM's tactical approach is to lower purchase prices to the point where prudent financial officers must consider purchase. Once maximum revenue is extracted from the resulting purchase activity, a new product is announced that effectively obsoletes the old one.

  - IBM's strategy at this point is directed toward destroying the residual value of purchased products. This can be done any number of ways:

    . By offering replacement products with obvious price/performance advantages.

    . By offering new software that can only be run on new systems.

    . By offering devices that are only supported on new systems.

. By taking old products off maintenance.

. With sheer salesmanship.

- Everyone knows the ploys that are used, but the strategy works so well that used computers are being scrapped faster than automobiles. After the September price reductions and mainframe announcements (which will be presented later), an INPUT client called to discuss residual values on a 4341 and commented: "Sometimes I think I will just keep everything on lease, what they (IBM) present as a great deal one day becomes a terrible deal the next day."

- Leasing companies run the risk of getting stuck with a bunch of old clunkers that are hardly worth the price of hauling them away, but users always have the option of driving the old jalopy for another year - it still has operational residual value.

- At this point, the customer can win the game, but surprisingly few ever win big. A little better mileage (price/performance), a little chrome (new operating systems release), a 50,000-mile maintenance agreement (improved reliability, availability, and serviceability a test ride (bench mark), and one can be the first in the neighborhood to have the latest model (be on the leading edge of technology). Besides, the kids (programmers) like to tell their friends about it, and it smells good. Yes, IBM is still the world's greatest sales organization.

- At the present time, IBM's observed pricing strategy can be summarized as follows:

  - Selling is obviously preferred to leasing. This is demonstrated by the following:

    . Purchase prices of the most popular products are being reduced.

  - Financing is being made easier to obtain through the establishment of the IBM Credit Corporation. (This also permits IBM to recover more of its "skimmed profits" without nearly as much risk as other financial institutions.)

  - Improved discounts are being made available on selected machines.

  - The maintenance costs of purchased machines are being reduced.

- IBM is moving toward lower cost (price competitive), high-volume products. Examples of this strategy are as follows:

  - Volume discounts are being offered on certain products.

  - The 308X processors have been very aggressively priced based on a fundamental lesson IBM learned on the 303X line - the market for large mainframes is price sensitive.

  - The 3380 disk systems are priced in anticipation of extremely high-volume shipments.

  - Then, of course, there are the obvious examples of the IBM minicomputer and personal computer product lines.

- While IBM still maintains its strict adherence to published prices (finance, not marketing, is in control), it is becoming more aggressive in negotiating concessions such as site test allowances, delivery schedules, and support.

C. SPECIFIC PRODUCT ACTIVITY

- At one time, IBM price adjustments occurred twice a year and were fairly predictably timed. But, price announcements now occur more frequently and are timed unpredictably, with rental/lease prices established separately from purchase prices. This probably does not so much reflect a shift in IBM pricing tactics as it does an improved system for implementing price changes (once again pointing up the importance of internal IBM information systems).

- IBM reduced purchase prices on its 3420 tape drives by 20% in August, and this was followed a week later by the STC announcement of its 4600 tape drive. While STC admits the IBM price reduction did influence the announced price of the 4600, it denies the industry reports that profit margins have been severely impacted. The expected announcement of new IBM tape technology continues to be delayed among rumors that problems with medium coating have not yet been solved.

- In September IBM lowered prices of the 3083, 3081, and 3084 processors by up to 14% in preparation for the announcement of the 4361 and 4381 processors. These price adjustments also are seen as confirming the announcement of the 308X replacement series (Sierra), which has been projected for late 1983 or early 1984.

- Exhibit II-1 presents IBM list and used market prices on selected IBM equipment during 1983 with a general assessment of the used market trend.

- Exhibit II-2 presents an update of the price trend history of selected IBM peripherals that was published in Residual Value Forecasts for IBM Disk, Tape, and Printer Systems in March 1983. Even with the recent adjustment to tape drive prices, the longer product life cycle relative to disk is still apparent.

EXHIBIT II-1

IBM LIST VERSUS USED MARKET PRICES FOR SELECTED IBM EQUIPMENT

($ thousands)

Model	December '82 List	December '82 Used	March '83 List	March '83 Used	June '83 List	June '83 Used	September '83 List	September '83 Used	Projected December '83 List	Projected December '83 Used	Market Trend
Processors:											
3081K32	$ 4680	$ 4400	$ 4680	$ 4305	$ 4180	$ 3860	$ 3685	$ 3400	$ 3685	$ 3300	Stable
3081G16	3720	3350	3720	3160	3260	2900	2835	2500	2835	2400	Stable
3083B16	2020	-*	2020	-*	1980	-*	1735	-*	1735	1560	Down
3083E16	1320	-*	1320	-*	1280	-*	1120	-*	1120	1000	Down
3083J16	2620	-*	2620	-*	2580	-*	2260	-*	2260	2050	Down
3033U16	1828	585	1828	535	1828	492	1828	460	1828	460	Down
3033N08	1274	360	1274	337	1274	300	1274	225	1274	210	Down
3031-6	845	53	845	45	845	45	845	35	845	32	Down
4331-K2	93	57	93	53	93	53	93	47	80	36	Down
4331-L2	113	72	113	70	113	68	113	64	95	45	Down
4341-L1	225	178	225	165	225	163	225	160	190	125	Down
4341-L2	350	275	350	260	350	255	350	250	300	195	Down
4341-M2	390	309	390	293	390	293	390	287	330	225	Down
DASD:											
3330-001	34	1	34	1	34	1	34	1	34	1	Stable
3330-011	48	2	48	2	48	1	48	1	48	1	Stable
3333-001	42	1	42	1	42	1	42	1	42	1	Stable
3333-011	57	3	57	2	57	1	57	1	57	1	Stable
3350-A02	42	22	42	22	32	18	32	14	32	12	Down
3350-A2F	52	25	52	25	40	22	40	16	40	14	Down
3350-B02	33	18	33	18	25	14	25	11	25	9	Down
3350-B2F	43	21	43	21	33	19	33	14	33	12	Down
3350-C02	43	20	43	20	33	15	33	10	33	8	Down
3370-A01	35	26	35	28	35	31	35	28	35	30	Up
3370-A11	35	26	35	28	35	31	35	28	35	32	Up
3370-B01	27	19	27	21	27	23	27	22	27	22	Up
3370-B11	27	20	27	21	27	23	27	22	27	22	Up
3375-A01	38	39	38	35	38	36	38	34	38	32	Down
3375-B01	29	30	29	26	29	27	29	26	29	25	Down
3380-A04	86	89	86	87	86	87	86	80	86	77	Down
3380-AA4	99	102	99	100	99	100	99	94	99	89	Down
3380-B04	72	74	72	72	72	72	72	67	72	65	Down

Continued

EXHIBIT II-1 (CONT.)

IBM LIST VERSUS USED MARKET PRICES FOR SELECTED IBM EQUIPMENT

($ thousands)

Model	December '82 List	December '82 Used	March '83 List	March '83 Used	June '83 List	June '83 Used	September '83 List	September '83 Used	Projected December '83 List	Projected December '83 Used	Market Trend
Tape:											
3420-003	$ 20	$ 2	$ 20	$ 2	$ 20	$ 2	$ 12	$ 2	$ 12	$ 1	Down
3420-005	25	3	25	3	25	3	16	2	16	1	Down
3420-007	27	4	27	5	27	5	18	4	18	3	Down
3420-004	22	12	22	12	22	13	15	12	15	7	Down
3420-006	25	14	25	13	25	15	18	15	18	10	Stable
3420-008	28	19	28	19	28	20	20	18	20	13	Stable
Printing:											
1403-N01	40	4	40	3	40	3	40	2	40	3	Stable
3211-001	40	20	40	20	40	22	40	22	40	20	Stable
3800-001	315	198	315	198	315	189	315	180	315	155	Down
3800-003	315	-*	315	-*	315	-*	315	-*	315	-*	Stable

Note: The values shown are IBM list price and used market retail price at end of period reported.

Prices listed for respective processors do not include either the Power Distribution Unit or the Coolant which is required for large mainframes.

All prices quoted on tape equipment include dual density feature 3550 for models 3,5,7 and 6425 or models 4,6,8.

Asterisk indicates newly announced product that as of the date of this report, no activity in secondary market has been reported. Used market price would be equal to or slightly greater than IBM list dependent upon availability and lead time for shipment from vendor.

EXHIBIT II-2

PRICE TREND HISTORY FOR SELECTED IBM PERIPHERALS

Type of Equipment	1964	1969-71	1973-75	1977-79	1980-81	1982	1983
Printers:							
1403N01	$ 39965	$ 33970	$ 38140	$ 40040	$	$	$
2821-2	27100	23040	25900	27190			
3211		69360	63630	53440	40080		
3811		30600	28080	23580	17685		
3800-001			310000	341750	358800	373150	315000
Tapes:							
3420-003		13580	12420	14340		14910	11930
3420-005		18170	16650	19230		19990	16000
3420-007	22380	20520	21540			22400	17920
3420-004		24000					
		21960	23050		18440	19170	15340
3420-006		28000					
		25650	26130		21540	22390	17920
3420-008		31000					
		28440	29860		23890	24840	19880
Disks:							
3350-B02			49500	31680		32940	
3375					32550	33850	
3380-B04					81000	84240	71600

Note: Prices shown were the IBM List Prices in effect at the end of the designated time period. The two figures shown for the 3420 models 4,6 & 8 are the list prices announced in the period reported.

- Exhibit II-3 shows the adjusted IBM price list for model conversions. Model conversions from the 3081 to the 3084 were reduced by approximately 12% at the time of the general price reductions on the 308X series in September 1983, encouraging users to upgrade to the top of the line.

- Exhibit II-4 illustrates the point that even maintenance costs play a significant role in giving customers "direction" toward IBM objectives.

  - Maintenance costs for the 3081 have declined sharply on the 3081 D16 (36%) from 1981 to 1983, whereas the 3033 U16 have declined only 10% during the same period. In other words, if you purchase a 3033 you will pay a premium for maintenance compared to the 3081 - 45% more in actual dollars ($6,555 compared to $4,500).

  - The increased maintenance costs of products with long life cycles (tape drives and printers) assure that IBM will receive substantial, continuing revenue regardless of whether the customer takes advantage of purchasing such equipment.

- IBM's pricing strategies and tactics can best be described as masterful in terms of directing customers toward IBM's goals, and awesome in terms of revenue (and earnings) maximization.

EXHIBIT II-3

IBM LIST PRICE OF MODEL CONVERSIONS FOR LARGE PROCESSORS

($ thousands)

Machine Type	Model	16	24	32	48	64
3081	D16		160	320		
	D24			160		
	G16		160	320	640	
	G24			160	480	
	G32				320	
	K16		160	320	640	
	K24			160	480	
	K32				320	
3083	E08	160				
	B08	160	320	480		
	B16		160	320		
	B24			160		
3084	Q32				320	640
	Q48					320
3081* to 3084	K16			2825	3145	3465
	K24				2985	3305
	K32					3145

* 3081K Models require feature #1550 for conversion.

EXHIBIT II-4

PRICE HISTORY OF IBM MAINTENANCE COSTS FOR SELECTED IBM EQUIPMENT

MODEL	1978	1979	1980	1981	1982	1983
Processors						
4341-L1	$515	$540	$594	$653	$593	$593
3031-6	3070	3070	2825	2490	2370	2370
3033U16	8975	8975	8255	7280	6555	6555
3081D16	-	-	-	7050	5290	4500
3081K32	-	-	-	-	6690	5785
DASD						
3330-011	170	170	170	178	178	178
3350-A02	170	170	170	170	170	170
3380-A04	-	-	-	285	285	285
Tape						
3420-007	124	142	179	235	253	235
3420-008	152	174	219	288	311	288
Printers						
1403-N01	392	450	544	687	687	687
3211-001	586	673	740	936	890	890
3800-001	-	710	816	938	938	938

Note: All prices reflect the then current IBM price at the end of the period reported.

Prices are reported for minimum maintenance coverage, i.e. 9 hour period scheduled between the hours of 7 AM and 6 PM Monday through Friday.

III ANNOUNCEMENTS OF SIGNIFICANCE

A. MAINFRAMES

- In May, National Advanced Systems, Inc. announced its 80XX series, which was pitted against the IBM 3083 mainframes and was reported to provide 20% better price/performance. After the IBM price adjustments in September, NAS followed immediately with price reductions designed to maintain this price/performance edge.

- In INPUT's last residual value forecast of IBM and software-compatible mainframes (December 1982), the following prediction was made: "The new high-end model is the Model 12 (4341) rated at about 1.5 MIPS. INPUT believes this completes the 4341 Series and that a new series will be introduced in the near future (the 4351) with a basic uniprocessor CPU rated at about 2.5 MIPS." The 4381-1 was announced at 2.1 MIPS and the 4381-2 at 2.7 MIPS in September, which effectively encompasses the prediction. In addition, 4361-4 and 4361-5 were announced rated at .8 and 1.1 MIPS, respectively.

- In another part of that residual value report, it was predicted that "the next product generation will be priced at time of announcement at about $175,000 per MIPS."

  - The 4361-4 is priced at $190,000 per MIPS.

- The 4361-5 is priced at $175,000 per MIPS.

- The 4381-1 is priced at $176,000 per MIPS.

- The 4381-2 is priced at $185,000 per MIPS.

- The "overpricing" of products at the low and high ends of the announcement can be attributed to problems of impact on existing 4341 and 3083 models in terms of price/performance, but both processors are basically priced as forecast.

- The price/performance ramifications of the 4361 and 4381 announcement will be discussed later in this report and analyzed fully in the mainframe residual value forecast scheduled for December 1983. However, the other significant aspects of the announcement are as follows:

  - The 4361, being priced under $200,000 and having a performance boost for scientific applications (the 4361 is stated to be six times faster than the 4331 for scientific applications and three times faster for commercial applications), is aimed at the supermini market as well as at traditional mid-range markets.

  - Purchased IBM 4321 and 4331 processors are field upgradable to the 4361, but leased machines are not. It is anticipated that this will stimulate purchase (to say nothing of protecting lease revenues) and meanwhile provide an excellent example of IBM's ability to control its revenue flow.

  - The 4381 is compatible with MVS/XA and provides the necessary low-cost stepping-stone to the high-end 308X line. It will put additional pressure on the plug-compatible vendors. (NAS slashed prices by 20% on its AS/6600 series of mainframes the following week.)

- Of equal importance, as an indication of IBM networking strategy, was the announcement of the IBM 4994 control unit, which provides for more economical attachment of ASCII-compatible terminals, printers, and plotters running under VM/CMS.

B. PERIPHERALS

- INPUT's last residual value forecasts for IBM disk, tape, and printer systems (March 1983) contained a section on optical disk storage systems, which had previously been forecast to appear in 1983. In late September STC announced an optical disk storage system with the following characteristics:

  - An Optical Media Unit (7440), which is a 14-inch removable platter that is nonerasable and has a storage capacity of four gigabytes and sells for $140 to $225 depending upon quantity.

  - The Optical Storage Unit (7640), which houses the high-speed spindle and read-and-write lasers with transfer rates of three million characters per second. The cost of the unit is $130,000.

  - The Storage Control Unit (8880), which operates under IBM's MVS/SP 1.3 operating system and is priced at $65,000.

  - Ten-year life is claimed for the optical media unit (platter) and error rates of 1 in 10 trillion bits are projected.

- Since STC did not want to reduce revenue from its magnetic tape and disk storage products, they did not price the 7640 aggressively, (however, the pricing may change rapidly since a one gigabyte optical disk for office systems, priced at $6,000, was announced after this report was prepared). Nevertheless, the STC 7640 will provide attractive alternatives to magnetic

tape for archival storage and to magnetic disk for large, relatively static, data files. STC is projecting $100 million in sales for the optical system in 1984, and eventually the impact of the technology must be felt among competing magnetic storage systems. (IBM's long-delayed tape announcement may have been due to anticipated competition from optical disks.)

- It has long been INPUT's opinion that cost-effective document storage will require the massive, low-cost storage represented by optical memories. The appearance of scanners that permit document entry, image processing, and eventually integration with conventional encoded data bases practically assures unprecedented demands for on-line storage.

  - In November 1982 IBM announced Scanmaster I, which INPUT projected would have dramatic impact on both communications networks and on the demands for on-line storage. (Executive Bulletin/Hardware, Operations; Volume 1, No. 1.)

  - In October 1983 Wang announced its Professional Image Processor (PIC) and hailed it as one of the "most important products in the company's history." The PIC system has the following characteristics:

    . A desktop scanner to digitize images from paper documents.

    . A high-resolution monitor to retrieve documents.

    . A desktop thermal printer to obtain hard copies.

    . The necessary communications software to provide a gateway to IBM networks, and the ability to send the digitized images to both Wang and non-Wang computer systems.

    . The PIC ranges in price from $15,000 to $26,700 depending on options and will be available in February 1984.

- The ability to implement electronic filing systems on mainframe computers is going to require enormous amounts of on-line storage, which will translate into a substantial shift in the relative costs of processors and peripheral storage. The current and projected costs of magnetic disk storage will not be competitive with those of optical memory systems in such environments. This has potential impact on the residual values of the magnetic storage systems being purchased today, and announcements of technology to support development of electronic offices will therefore be carefully monitored by INPUT.

C. SOFTWARE

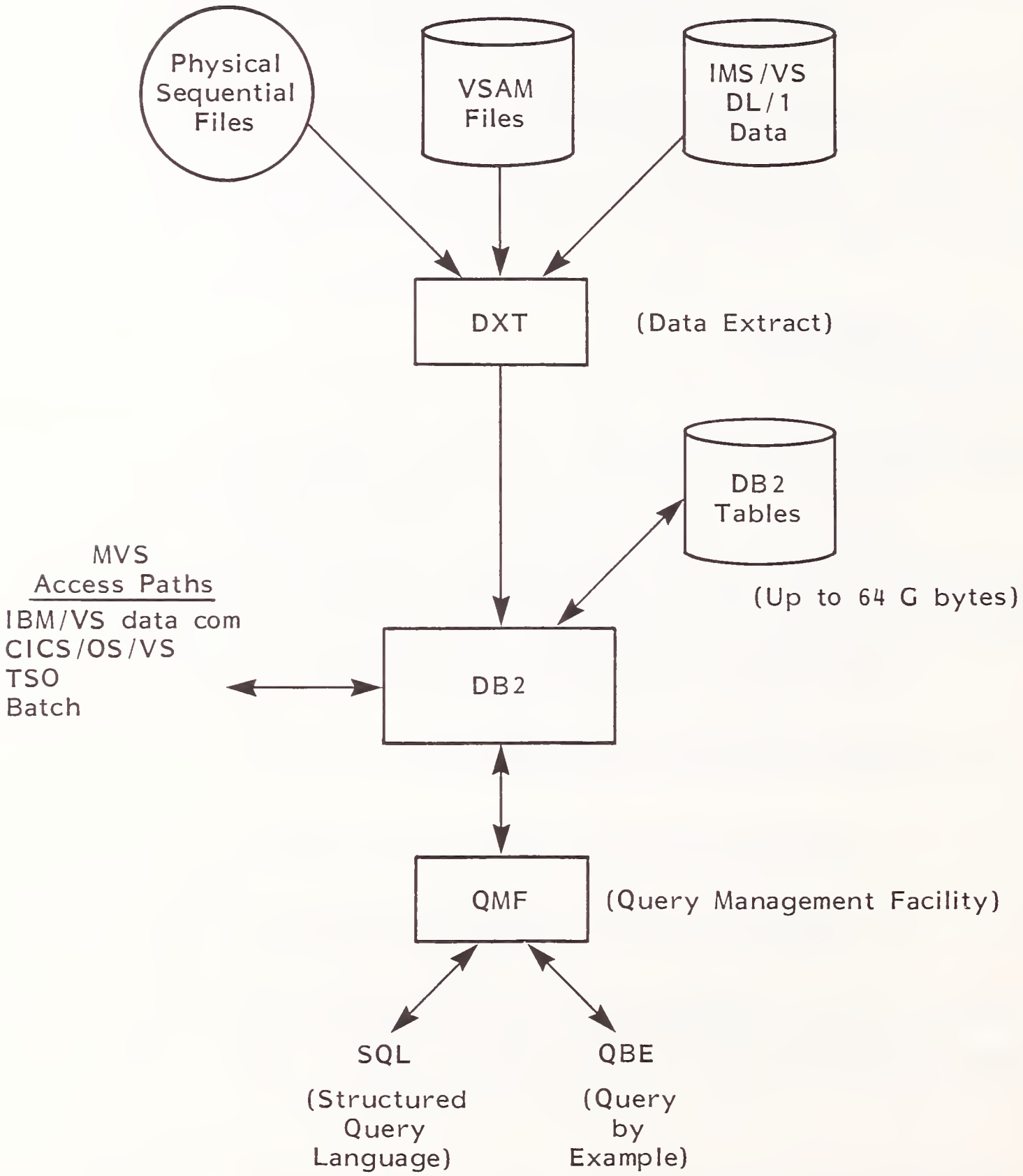
- As mentioned previously in this report, systems software support (or the lack thereof) can be used to obsolete existing installed hardware - this is all an accepted part of the elaborate game that was described earlier. Periodically, however, there are systems software announcements that obviously represent a turning point in the industry - IBM's announcement of virtual storage marked such a shift for the IBM product line. (XA, by contrast, is merely a necessary step in supporting virtual systems and a convenient means of leading customers along IBM's strategic path.)

- In terms of eventual impact on IBM's entire product line, the announcement of relational DBMS (DB2) in June 1983 may mark a significant turning point in IBM systems architecture. While this announcement was analyzed in some detail in Relational Data Base Developments published by INPUT in August 1983, the most important conclusions will be summarized here. Exhibit III-1 presents the general architecture of DB2.

  - The first conclusion that can be reached about DB2 is that it is potentially an enormous resource burner if used against large transaction-

EXHIBIT III-1

DB2 GENERAL ARCHITECTURE



oriented data bases. This conclusion is supported by published IBM research on System R performance and IBM's general reluctance to announce the product because of poor performance (even by IBM standards).

- The second conclusion is that current IBM mainframe architecture is not especially well suited for solving the performance problems, and that a data base machine may be required (either a backend data base processor or a separate data base processor integrated under the covers of Sierra). Availability in the second and third quarter of 1984 may be intentional in order to await announcement of the 308X replacement and demonstrate that there is help on the way in terms of processing power to drive the beast. Under any circumstances, it is probable that executing joins on large relational tables will demonstrate the necessity for the new system by bringing the 3084 to its knees.

- While everyone knows that relational operators (such as JOIN) should not be used against large data bases, the relational tables against which DB2 can operate can be up to 64 gigabytes, as shown in Exhibit III-1. In addition, these tables are built by extracting data from existing files (including IMS, VSAM, and even archival tape files). The processing power and amount of storage required to extract and use these data will establish entirely new standards for large-scale systems unless use is carefully controlled. The benefits of relational systems are flexibility and ease of use - precisely what are needed to accommodate today's trends toward prototyping and end-user development. Control is unlikely - the software performance problems will require new technology.

- Relational DBMS is necessary (or at least highly desirable) if knowledge-based systems are to be developed, and knowledge-based systems are the key to improving white-collar productivity. However, current hardware systems will rapidly become obsolete as new architectures

for both processors and storage systems are required for implementation.

- DB2 will operate in both MVS/370 and MVS/XA environments, but a substantial resource penalty results if it is not run under XA because it was theoretically the first system specifically designed for the XA environment. However, it is probable that the combination will not achieve acceptable performance levels until new hardware/software architectures are forthcoming.

D. INTELLIGENT WORKSTATIONS

- After this report was prepared, IBM announced the Personal Computer XT/370 and the IBM 3270 Personal Computer, along with a host of software to support distributed processing at the local level. While the XT/370 does not yet fully meet the price/performance level of the desktop 32-bit micro that will be postulated later in this report (Exhibit IV-1), there seems to be little question that an enormous amount of processing power will be available at the desktop very soon. In addition, the capability has been provided to transfer substantial amounts of data from central data bases to personal data bases. IBM's version of distributed processing is suddenly bursting upon the scene after excruciatingly slow progress over the last decade.

- Among the flurry of significant IBM announcements in September and October, this announcement is by far the most significant, and it will require careful analysis. However, while the implication is clearly towards distribution of both processing and data bases away from the host, do not plan to write off your 308Xs or 3380s just yet - the large central facility is still key to SNA.

IV MAINFRAME STRATEGY REVIEW

- The announcement of the 4361 and 4381 processors emphasizes once again the topsy-turvy world IBM has created in processor price and performance. Essentially, the newly announced processors have two times the price/performance of the 308X series. This violates classic theories of economy of scale, which were observed to have a quadratic effect that assumed a "four-fold increase in effectiveness for a doubling of cost."

- INPUT explored this phenomenon along with the economics of computer/communications networks a number of years ago (Economics of Computer/Communications Networks and Their Future Impact, March 1976), and concluded that the IBM mid-range systems were under substantial price/performance pressure from very large mainframes (IBM 168 and the newly announced Amdahl V6) and minicomputers.

- It was observed that this threatened a cardinal tenet of IBM's mainframe stragegy - specifically, that of providing an orderly progression of compatible mainframes. The conclusions reached in this report received sufficient attention during the mid-1970s to warrant a statement from IBM that their customers still required the "stepping stone" product line that was initiated with System/360.

- The announcement of the 43XX series in 1979 was specifically directed toward slowing the impact of distributed processing as represented by the economics of hierarchical computer/communications networks consisting of

large central mainframes and distributed minicomputers. IBM was largely successful in this effort but as recently as this year has publicly acknowledged that large mainframes sales were better than those for mid-range systems.

- At the same time, it was also observed that there were more MIPS installed on microprocessors than on large-scale mainframes. It is obvious that MIPS is an imperfect measure of effectiveness, but it is also true that revolutionary changes are taking place in the economics of computing, and some of these changes are enlarging the Achilles heel of IBM large-scale systems - software. When an end user in a large corporation sits down to do his planning on a personal computer using VisiCalc and ignores the 308X with its elaborate supporting software, it is time to start thinking seriously about the future of such systems.

- The rough price/performance characteristics of the current IBM product line give some indication of the problem, as shown in Exhibit IV-1.

  - When the systems are ordered by their performance characteristics, the newly announced 4361 and 4381 processors demonstrate clearly their proper place in the product line. However, on a price/performance basis they obviously have established a new standard for IBM mainframes.

  - The higher relative price/performance of the 4361 also seems to confirm that the battle with the minicomputers is considered more serious than any immediate threat from a new software-compatible mainframe.

  - The current speculation about the impact of microprocessors on minicomputers is highlighted in the chart by inserting a potential 32-bit, microprocessor-based, desk-top computer priced at $10,000. It is obvious that price/performance of mainframes will not be competitive even with the establishment of the new standard as represented by the recent announcements of the 4361 and 4381.

EXHIBIT IV-1

PRICE/PERFORMANCE OF SELECTED IBM SYSTEMS

SYSTEM & MODEL	PERFORMANCE	PRICE/ PERFORMANCE*
4331-1	.03	1.03
4331-2	.03	1.25
4341-1	.06	1.25
4361-4	.07	2.13
4341-2	.10	1.21
4361-5	.10	2.13
4381-1	.15	1.73
4381-2	.20	1.68
3083-E8	.27	.98
3083-B16	.41	.88
3081-K16	1.00	1.00
3084	1.90	.94
Possible Desktop, 32-bit Micro	.10	42.00

*IBM 3081-K16 = 1.

- It is INPUT's opinion that IBM's mainframe strategy is essentially oriented around SNA and is designed to ensure the need for large central hosts and mainframe-oriented systems at the nodes. In other words, it is essentially a software-oriented strategy with large-scale systems continuing to be required essentially to run the complex software that has evolved over the past two decades. Surprisingly, this strategy makes more sense now than it ever has before - it is comparable to going past the point of no return - IBM has led the industry this far and turning back is no longer an option.

- In view of this conclusion, INPUT believes that the economics of computer/communications networks should be reexamined in detail, and will do so in the next residual value forecast report on IBM and plug-compatible mainframes, which will be published in December 1983.

V UPDATE RESIDUAL VALUE FORECASTS

- The price adjustments and announcements that have been presented in this report were anticipated and even predicted in INPUT's previous residual value reports. Therefore, the mainframe and residual value forecasts that were made in the most recent reports (December 1982 and March 1983) remain essentially correct. However, the preliminary analysis of price/performance characteristics of the IBM mainframe announcements and the potential impact of technological advances in microprocessor development on the economics of computer/communications networks may be of sufficient significance to cause adjustments of large-scale mainframe residual value projections. More detailed analysis of these factors and used market activity is currently in progress, and a complete update of IBM and plug-compatible mainframe residual value forecasts will be published in December 1983.

- Used market average retail values (as a percent of IBM list price) in March, June, September, and December of 1982 and March, June, and September of 1983 for selected IBM equipment is presented in Exhibit V-1.

  - The September prices reflect the pricing changes for 308X processors and tape drives that were discussed in Chapter II.

  - The only significant changes (as a percentage of IBM list price) occurs with tape drives where a substantial list price reduction and stable used market retail prices caused a significant increase in the percentage figures for the older models. This is not unusual when used market prices approach scrap value.

EXHIBIT V-1

USED MARKET AVERAGE RETAIL PRICES FOR SELECTED IBM EQUIPMENT (AS A PERCENT OF IBM LIST)

Model	1982 March	1982 June	1982 September	1982 December	1983 March	1983 June	1983 September
4341-L2	87%	86%	83%	79%	74%	73%	71%
4341-M2	87	89	82	79	75	75	74
3031-6	14	11	9	6	5	5	4
3032-8	28	18	11	8	5	4	4
3033N08	59	35	38	28	26	24	18
3033U16	62	41	43	32	29	27	25
3081D/G16	102	100	92	90	85	88	88
3081K32	102	100	100	94	92	92	92
3330-001	18	10	6	3	3	3	3
3330-011	38	23	7	4	3	3	2
3350-A02	73	65	59	52	52	55	44
3350-B02	73	65	60	53	53	55	44
3380-AA4	130	108	104	103	101	101	97
3380-B04	130	108	105	103	101	101	96
3420-003	19	11	9	8	8	8	16
3420-005	17	13	11	10	10	10	13
3420-007	29	23	18	13	17	17	22
3420-004	54	47	52	55	55	57	60
3420-006	66	64	62	54	50	58	67
3420-008	80	76	80	69	67	71	75
1403-N01	14	11	8	7	5	4	7
3211-001	55	55	55	50	55	55	55
3800-001	65	63	63	63	63	60	57

The values shown are used market retail prices. At any given time, three price levels exist:

Retail Price - The amount an end user would pay for the equipment.

Dealer Price - The amount a dealer would pay another dealer to acquire equipment to complete a contracted sales obligation.

Wholesale Price - The amount a dealer would pay to acquire equipment for resale.

The dollar spread between levels is a function of the total value of the transaction. For large processors the wholesale price will typically be 80% to 95% and for peripheral equipment 70% to 90% of the retail price.

- There is one product line that does need readjustment, and that is the 3380 disk drive where the market has remained exceptionally strong.

  - In September 1982 INPUT projected that the January 1, 1984, used market retail price of the 3380 A04 would be $75,100 (See Exhibit III-3, Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, September 1982.)

  - The September 1983 used market retail price of the 3380 A04 was $80,000, and the projected price for December 1983 is $77,000. (See Exhibit II-1 of this report.) This confirms the September 1982 forecast.

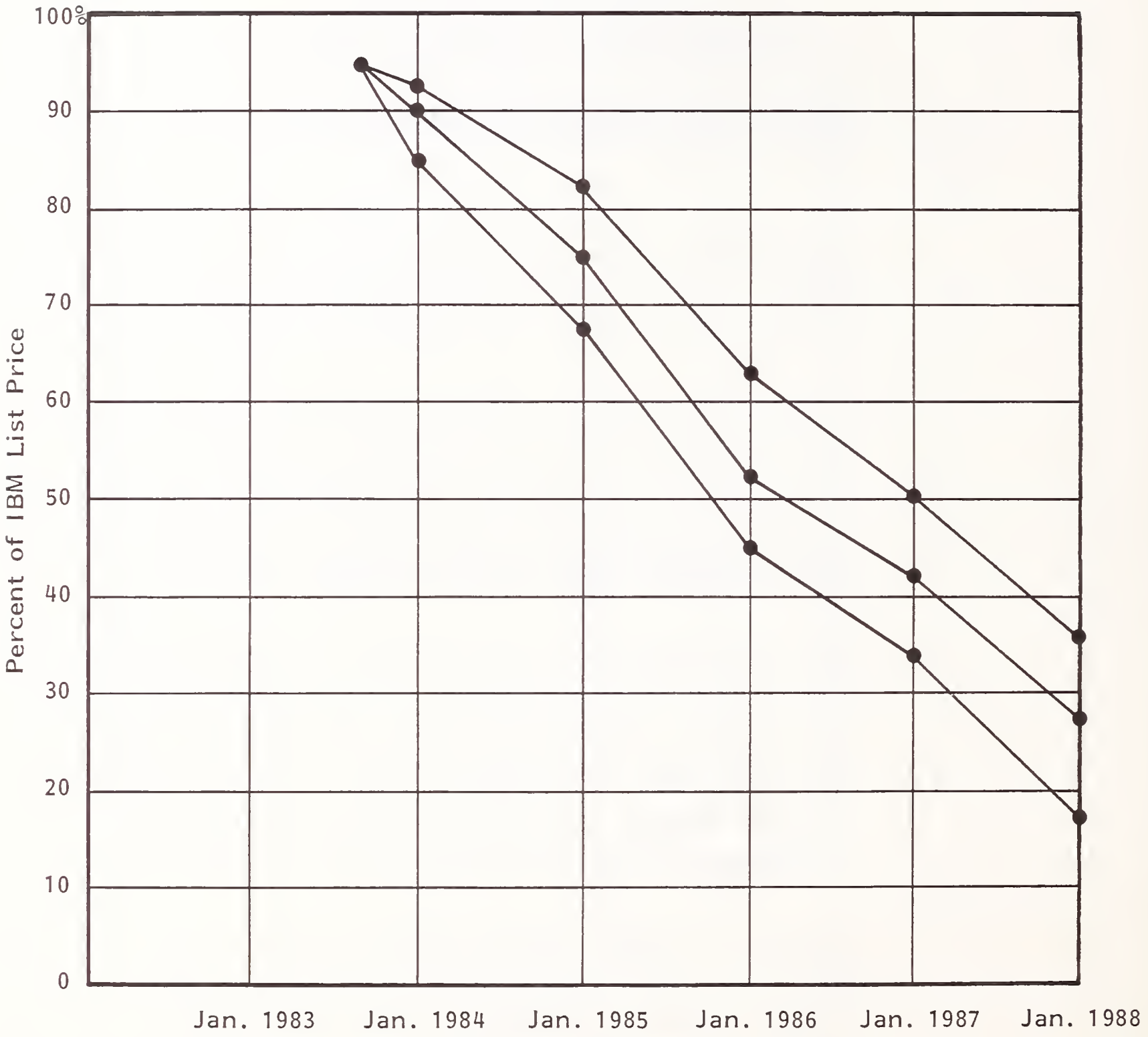
  - Unfortunately, in March 1983 the September 1982 projections were revised in light of 3380 price adjustments that occurred in December 1982, and the used market value of the 3380 A04 was projected to be $67,300 on January 1, 1984. (See Exhibit III-4, Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, March 1983.)

  - While the analysis that led to the March 1983 forecast still seems logical, actual values did not work out accordingly. IBM has reached full production, customers are accepting deliveries, and demand for on-line storage seems practically unlimited. IBM is seriously questioning the price sensitivity of the disk storage market, and many customers are beginning to realize that demand seems to be out of control.

  - Exhibit V-2 contains updated projected residual values for the IBM 3380. Essentially, this projection readjusts the March 1983 numbers for January of 1984 and 1985 back to those that were made in September 1982. The projected used market retail prices are shown in Exhibit V-3.

EXHIBIT V-2

PROJECTED RESIDUAL VALUES FOR THE
IBM 3380 DISK DRIVE



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	92	82	62	50	36
Expected	87	78	52	42	28
Low	85	68	46	34	18

EXHIBIT V-3

PROJECTED USED MARKET RETAIL PRICES FOR
SELECTED MODELS OF THE IBM 3380 DISK DRIVES

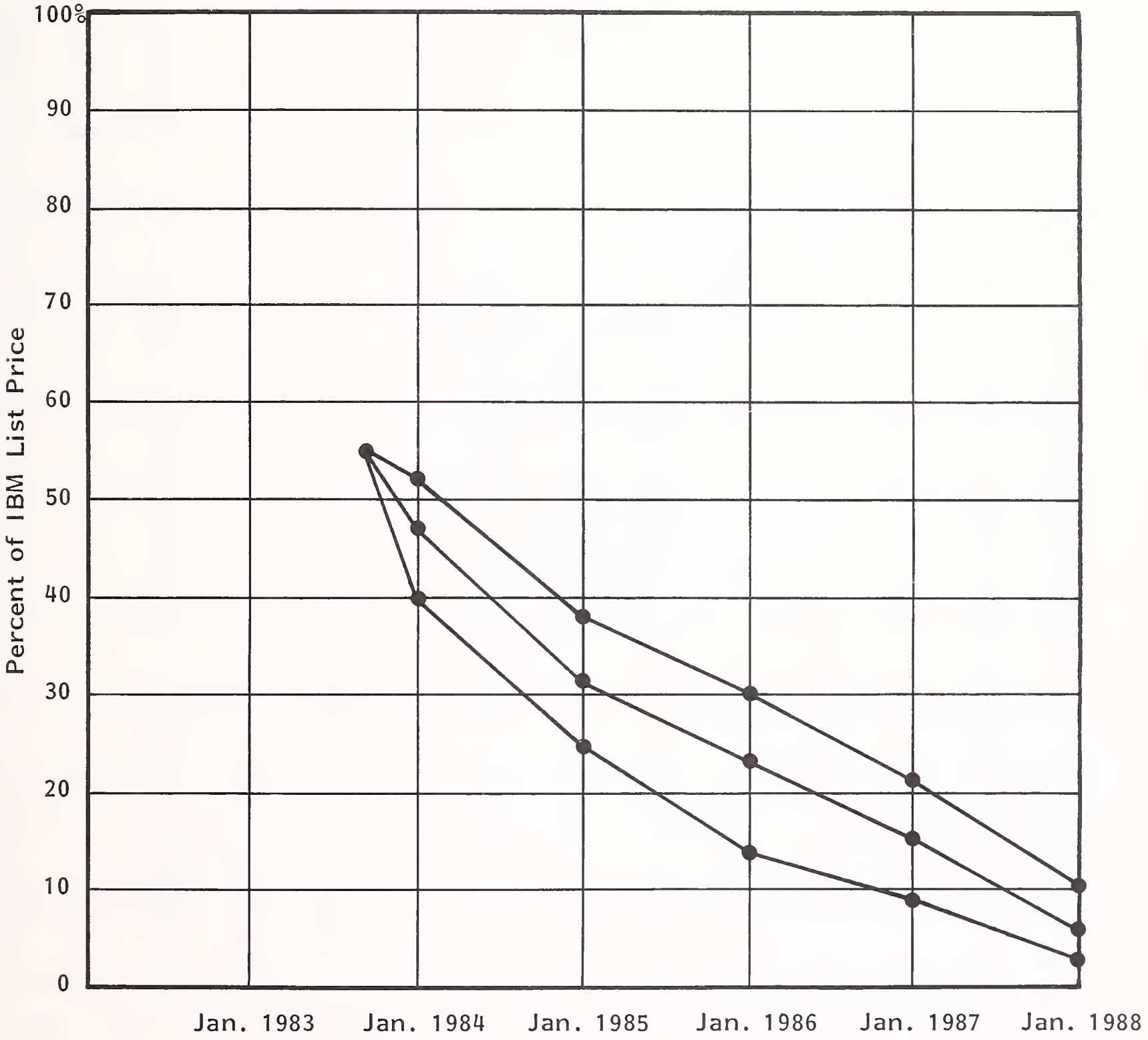
MODEL	CURRENT LIST	PROJECTED USED MARKET RETAIL PRICE AT JANUARY 1, OF:				
		1984	1985	1986	1987	1988
3380 AD4	$86,310	$77,700	$64,700	$44,900	$36,300	$24,200
3380 BO4	71,600	64,400	53,700	37,200	30,100	20,000

- Exhibits V-4 and V-5 present projected residual values for IBM 4331 and 4341 processors. These values are the wholesale used market price as a percentage of IBM list price at the time of the transaction. (Please refer to footnote on Exhibit V-1 for definitions of used market price levels.)

- Exhibit V-6 presents the projected residual values for the NAS AS/8000 processors that were announced in May 1983. Residual values of NAS processors are difficult to forecast because of the limited used market activity. However, there is a loyal and even enthusiastic customer base that may create some activity later in the product life cycle.

EXHIBIT V-4

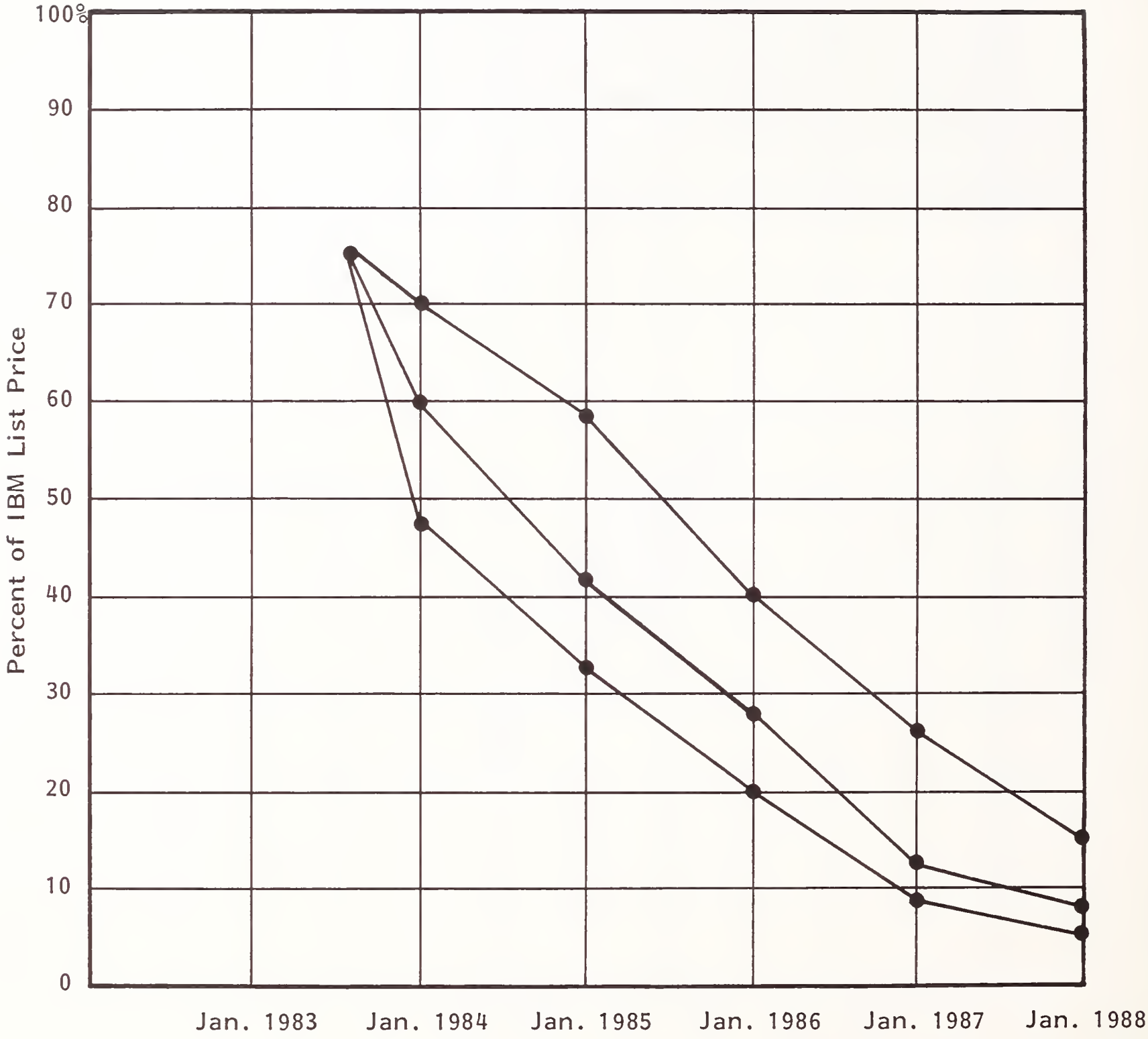
PROJECTED RESIDUAL VALUES FOR
IBM 4331 PROCESSORS



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	52	38	30	21	10
Expected	48	32	24	16	7
Low	40	26	15	9	4

EXHIBIT V-5

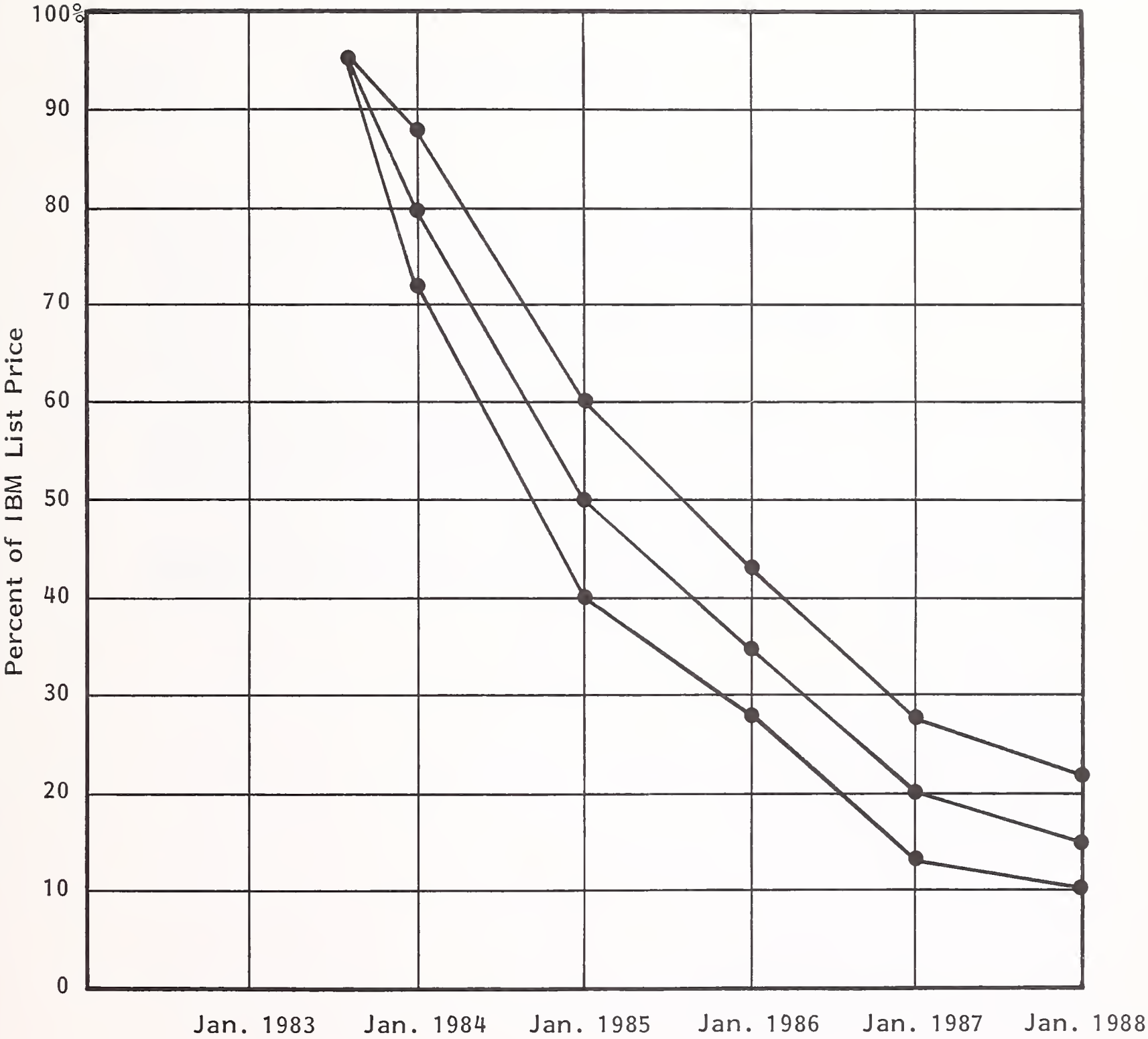
PROJECTED RESIDUAL VALUES FOR
IBM 4341 PROCESSORS



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	70	58	40	26	15
Expected	60	42	28	12	8
Low	48	34	20	9	5

EXHIBIT V-6

PROJECTED RESIDUAL VALUES FOR
NAS AS/8000 PROCESSORS



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	87	60	43	27	22
Expected	80	50	35	20	15
Low	73	40	28	13	10

APPENDIX: RELATED INPUT REPORTS

- Impact of Office Systems on Productivity, November 1983.
- Impact of Upcoming Optical Memory Systems, April 1983.
- Residual Value Forecasts for Large IBM and Software Compatible Mainframes, December 1982.
- Residual Value Forecast for IBM Disk, Tape, and Printer Systems, August 1983.

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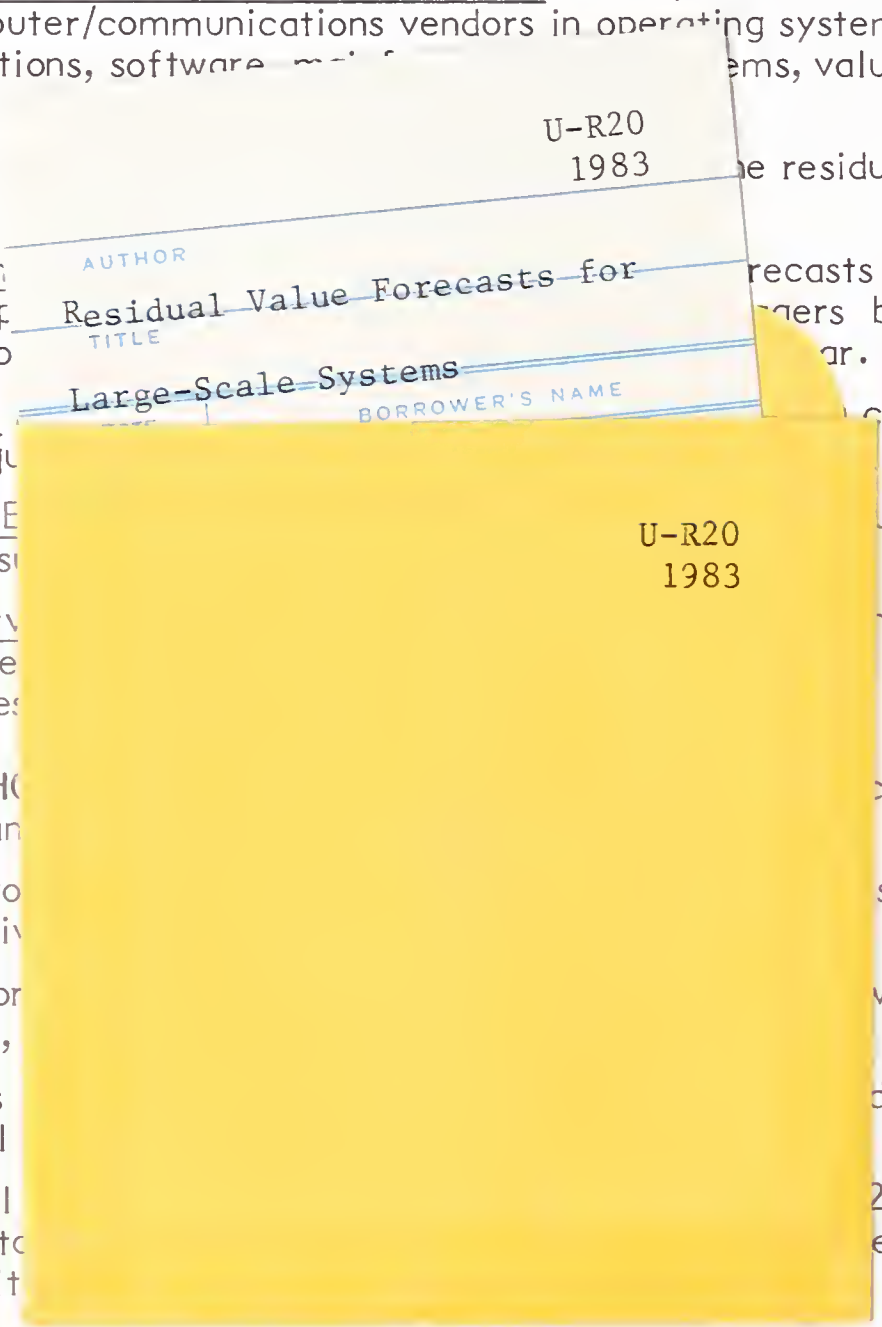

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INFORMATION SYSTEMS PROGRAM

RESIDUAL VALUE FORECASTS
FOR LARGE-SCALE SYSTEMS

DECEMBER 1983

RESIDUAL VALUE FORECASTS FOR LARGE-SCALE SYSTEMS

CONTENTS

EXHIBITS

I INTRODUCTION

- This residual value forecast is produced as part of INPUT's Management Planning Program in Information Systems. Residual value projections in this series of reports are updated at least once each year for the systems covered. The last full set of residual value forecasts for large IBM and software-compatible mainframes was published in December 1982, and an update of specific products covered in the series was published in November 1983.

- This report contains a complete set of forecasts for all mainframes covered, and also presents a general analysis of the current environment in which mainframes compete. This analysis will emphasize cost alternatives in delivering processing power through used market purchases and offloading of the mainframe in a distributed processing environment.

- Chapter II will review the relative price/performance of selected mainframes based on manufacturers' list price or used market prices. It will become obvious that mainframe "MIPS" are not considered a commodity by those responsible for equipment selection.

- Chapter III will review major announcements that could potentially impact mainframe residual values as previously published. For the first time, non-mainframe announcements will be listed as being of potential significance to future residual values of large mainframes.

- Chapter IV will present a brief analysis of the economics of computer/communications networks and the impact of distributed processing (both architectures and geographic) on the future of large host processors. This is done in the belief that there will be significant shifts in the large mainframe processing environment during the period for which residual values are being forecast.

- Chapter V contains five-year residual value forecasts for selected IBM, Amdahl, and National Advanced Systems (NAS) processors. The recently announced IBM 4361 and 4381 processors are included, and separate forecasts are made for IBM 3083 E&J and 3081 G&K processors. In addition, the following processors are included: IBM 4331, 4341 and 3033; Amdahl 5860, 5880 and 470V/8; and the NAS 6000, 8000, and 9000 series.

- The analysis contained in this report is an extension of that presented in INPUT's Residual Value Forecast: Fall Update, November 1983. It is important to understand that the true value of a mainframe processor is represented only roughly by the manufacturer's list price and its residual values. IBM is exercising increasing control over the IBM and software-compatible marketplace. Failure to recognize this fact can lead to unpleasant surprises.

II BARGAINS IN THE USED MARKET

- Used market activity of IBM mainframes was covered in INPUT's Residual Value Forecast: Fall Update, November 1983. That report also made the point that the residual value did not necessarily reflect the true useful value of the product. In other words, there should be some real bargains in the used market. In this report, we will identify some of them.

- To effect this identification, INPUT decided to view MIPS as a commodity and to analyze selected list and used market prices of various processors against the ability to execute one million instructions per second (MIPS). The results of this simple analysis are presented in Exhibit II-1, and they reveal more than bargains in the used market.

- The real bargains are easy to spot:

  - An IBM 3033-U or 3808-B has roughly equivalent power (5.0 and 5.6 MIPS respectively), but the 3033 can be purchased on the used market for one-quarter the cost per MIPS ($72,000 versus $281,000).

  - An IBM 3032-6 with the same power as the recently announced 4381-2 (2.5 MIPS) has recently traded on the used market for less than 10% of the cost of the 4381-2 ($35,000 versus $54,000 purchase price for the minimum configuration).

EXHIBIT II-1

PRICE/PERFORMANCE OF SELECTED MAINFRAMES

MODEL NUMBER	MIPS RATING	PURCHASE PRICE OF MINIMUM CPU CONFIGURATION ($000)	($000/MIP)
IBM			
3084-Q	27.0	$6,190	$229
3081-K*	14.0	3,030	216
3081-G*	10.5	2,495	227
3083-J	7.4	2,100	284
3083-B	5.6	1,575	281
3083-E	3.2	960	300
3033-U*	5.0	360	72
3032-6*	2.5	35	14
3031-4*	1.1	17	15
4381-2	2.5	544	218
4381-1	1.8	374	208
4361-5	1.2	230	192
4361-4	0.9	175	194
4341-2*	1.3	212	163
4341-1*	0.8	138	173
4331-2*	0.4	62	155
4331-1*	0.2	28	140
AMDAHL			
5880	23.4	5,300	226
5860	13.0	2,700	208
470-V/8*	6.5	450	69
470-V/7*	5.5	375	68
470-V/7B*	3.5	250	71
NAS†			
AS/9080	20.0	4,900	245
AS/9070	16.2	3,600	222
AS/9060	11.2	3,000	268
AS/8060	7.8	2,200	282
AS/8050	6.1	1,600	262
AS/8040	4.9	1,100	224
AS/6650	2.4	417	174
AS/6630	2.0	341	171
AS/6620	1.6	255	159

*Indicates current used price of minimum configuration.

†NAS list prices are an approximation and include the processor, console and power supply.

- Amdahl 470 systems on the used market sell for approximately 27% the cost per MIPS of the Amdahl 58XX systems.

- While the newly announced IBM 4361 and 4381 have a significant price/performance edge over the 4331 and 4341 at list price (see Residual Value Forecasts: Fall Update), the average cost per MIPS in the used market for 4331 and 4341s offers a price advantage of approximately 20% under the 4361 and 4381.

- It becomes readily apparent that MIPS are not a commodity that can be shopped for in the market; otherwise, the price spread between list prices and used market prices would tend to narrow. Numerous factors come into play when deciding on new versus old (used) mainframe technology. Aside from planned obsolescence through vendor control of software and device support, and the manipulation of maintenance costs (also discussed in the residual value update, November 1983), there are other costs that offset some of the price advantages of the older systems.

- The list price cost per MIPS can also be used as a rough assessment of value among competing mainframes. And the following conclusions can be reached from Exhibit II-1.

  - Mid-range systems (IBM 43XX and NAS AS/66XX) offer better price/performance than their big brothers. This reflects the continuation of IBM's 1970s strategy of protecting mid-range systems against the classic economy-of-scale advantage of large-scale systems and the price/performance superiority of minicomputers.

  - The recent list price adjustments of Amdahl and NAS, following IBM purchase price adjustments in September, demonstrate a tendency to keep list prices of software-compatible mainframes rather close to IBM's, and to provide flexibility of discounting when in specific head-to-head competition. NAS, in particular, has an extremely competitive discount posture in the marketplace.

- However, the NAS reaction to the IBM 4361 and 4381, as illustrated by AS 66XX pricing, clearly demonstrates the necessity for announcing clear price/performance advantage against newly announced systems.

  . Even the list price of the AS 6650 is 20% lower than the 4381-2.

  . And the AS/6640 is 24% less than the IBM 4381-1 and 18% less than the IBM 4361-5.

- Exhibit II-2 shows the electrical power, air conditioning, and floor space requirements for certain IBM, NAS, and Amdahl processors. The range of requirements on a per-MIPS basis demonstrates clearly that there are quantifiable costs associated with the use of older technology. For example, the Amdahl V/6, which effectively obsoleted the IBM 370 line in the mid-1970s, now requires 10 times the power, 8 times the air conditioning, and 5 times the floor space of the IBM 3081 on a per-MIPS basis. The IBM 3033 and Amdahl 470 V/8, currently available in the used market, also demonstrate significant increases in installed costs compared to their 3081 and 5860 replacement systems.

  - The 3033 requires 8 times the power, 7.6 times the air conditioning, and 4 times the floor space of the 3081.

  - The 470 V/8 requires 3 times the power, 2.6 times the air conditioning, and 2.2 times the floor space of the 5860.

- The only conclusion that can be reached is that MIPS cannot be easily evaluated strictly by cost. Bargains in the used market must be carefully evaluated, but they are available for prudent IS managers in many cases.

EXHIBIT II-2

ELECTRICAL POWER, AIR CONDITIONING, AND FLOOR SPACE REQUIREMENTS
FOR CERTAIN IBM, NAS, AND AMDAHL PROCESSORS

VENDOR	IBM			NAS			AMDAHL		
Model	3033	3083	3081	AS6630	AS8050	AS9060	470 V/6	470 V/8	5860
MIPS Rating	(5.0)	(3.2)	(10.5)	(2.0)	(6.1)	(11.2)	(3.5)	(6.5)	(13.0)
Electrical Power (KVA)	83.3 (16.7)*	15.7 (4.9)*	21.6 (2.1)*	6.1 (3.1)*	22.9 (3.8)*	37.8 (3.4)*	74.5 (21.3)*	57.0 (8.8)*	37.5 (2.9)*
Heat Output (BTU)	218,150 (43,630)*	44,610 (13,940)*	60,320 (5,745)*	4,391 (2,196)*	70,990 (11,638)*	116,000 (10,357)*	174,100 (49,743)*	145,940 (22,452)*	112,950 (8,688)*
Floor Space (Square Feet)	138.7 (27.7)*	72.8 (22.8)*	72.8 (6.9)*	10.67 (5.3)*	43.4 (7.1)*	107.0 (9.5)*	124.1 (35.4)*	88.2 (13.6)*	78.7 (6.1)*

*Per MIP.

III REVIEW OF 1983 VENDOR ANNOUNCEMENTS

- 1983 may eventually be recognized as the year IBM demonstrated that its internal administrative systems provide a tremendous competitive advantage in the marketplace. New product announcements from PCs to mainframes were indeed inpressive, and numerous price adjustments designed to encourage purchase have put the competition in reaction mode and have pumped up 1983 IBM earnings by nearly 25%. During the first nine months of the year, outright sales rose by 44% and rentals were down by 15%. A look at 1983 IBM mainframe announcements will show how these results were achieved.

A. IBM ANNOUNCEMENTS

- In January, IBM offered a 30% discount on 3081 model D processors with 16 channels to state and local government agencies. The discount applied to both new orders and installed rented/leased machines. (This followed a 40% discount for educational institutions that had been announced in November 1982.)

- In February, a general rental/lease price increase was announced for a broad range of IBM products including the 3033 and 4300.

- In April, IBM introduced two 48 MB models of the 3081 series for those customers intending to move to the new MVS/XA operating system.

- In May, IBM announced that, effective January 1, 1984, it will only pass the investment tax credit through to customers who plan to purchase the equipment within the first six months of a rental or lease agreement (another way of encouraging purchase).

- Also in May, price reduction on model 3081 and 3083 processor upgrades and memory were announced. The effect of these price changes is a 1-5% reduction in total system costs for those models. In addition, maintenance rates on 3033, 3081, 3082, 3083 and 3084 machines were cut between 10% to 15%.

- In preparation for new 4300 series announcements, purchase prices of all 3083, 3081, and 3084 processors (and conversion upgrades) were reduced 11% to 14% in September. Specifically excluded was the 3081 model D to model K upgrade, which remained at $600,000.

- A week later in September, IBM announced the long-awaited "Glendale" processors. The 4361 (.9-1.2 MIPS) is field upgradable from 4321 and 4331 for user-owned machines only (another stimulus to purchase in case you hadn't noticed). The 4381 (1.8-2.5 MIPS) will operate under MVS/XA and provide a bridge to the 308X series. The maximum accrual period for purchase option credits is six months, and the 4361 accrues at 65% and the 4381 at 20%.

- At the same time, prices were reduced by up to 12% on selected 4331 and 4341 processors and up to 25% on memory for the 4321, 4331, and 4341.

- In October, the 3084 model Q96 was announced providing main memory capacity of 96M bytes. Essentially this represents the logical growth path for the 3081 K 48 processor that was announced earlier.

- Also announced during 1983 was a harbinger of what you may want to do with all of the memory and processing power that is becoming available - IBM announced DB2 for large systems with availability in 3Q 84. (See INPUT's Information Systems Issue Report, Relational Data Base Developments, August 1983.)

B. OTHER ANNOUNCEMENTS

- NAS announced the introduction of their new AS/8000 series of processors in May. This series is in direct competition with the IBM 3083 and is generally stated to provide 20% better price/performance (see Exhibit II-1).

- Otherwise, both NAS and Amdahl found themselves in a general reaction mode to the numerous IBM announcements and price adjustments.

IV THE ECONOMICS OF COMPUTER/COMMUNICATIONS NETWORKS

- In addition to the mainframe-oriented announcements listed in Chapter III, IBM made a major distributed processing announcement on October 18, 1983 (see INPUT's Executive Bulletin/Hardware Operations, "3270 PC + XT/370 + 8150 = IBM's DDP," December 1983). When considering the future of large-scale mainframes, and consequently their residual value, it is important to understand their function in relation to other components of computer/communications networks. IBM's October announcements signaled a significant shift in the classic processing hierarchy, and it is ironic that the precise day of those announcements was "black Tuesday" for Digitil Equipment Corporation. It was on October 18 that DEC announced sharply reduced quarterly earnings. Sometimes it doesn't pay to become number two - especially to IBM.

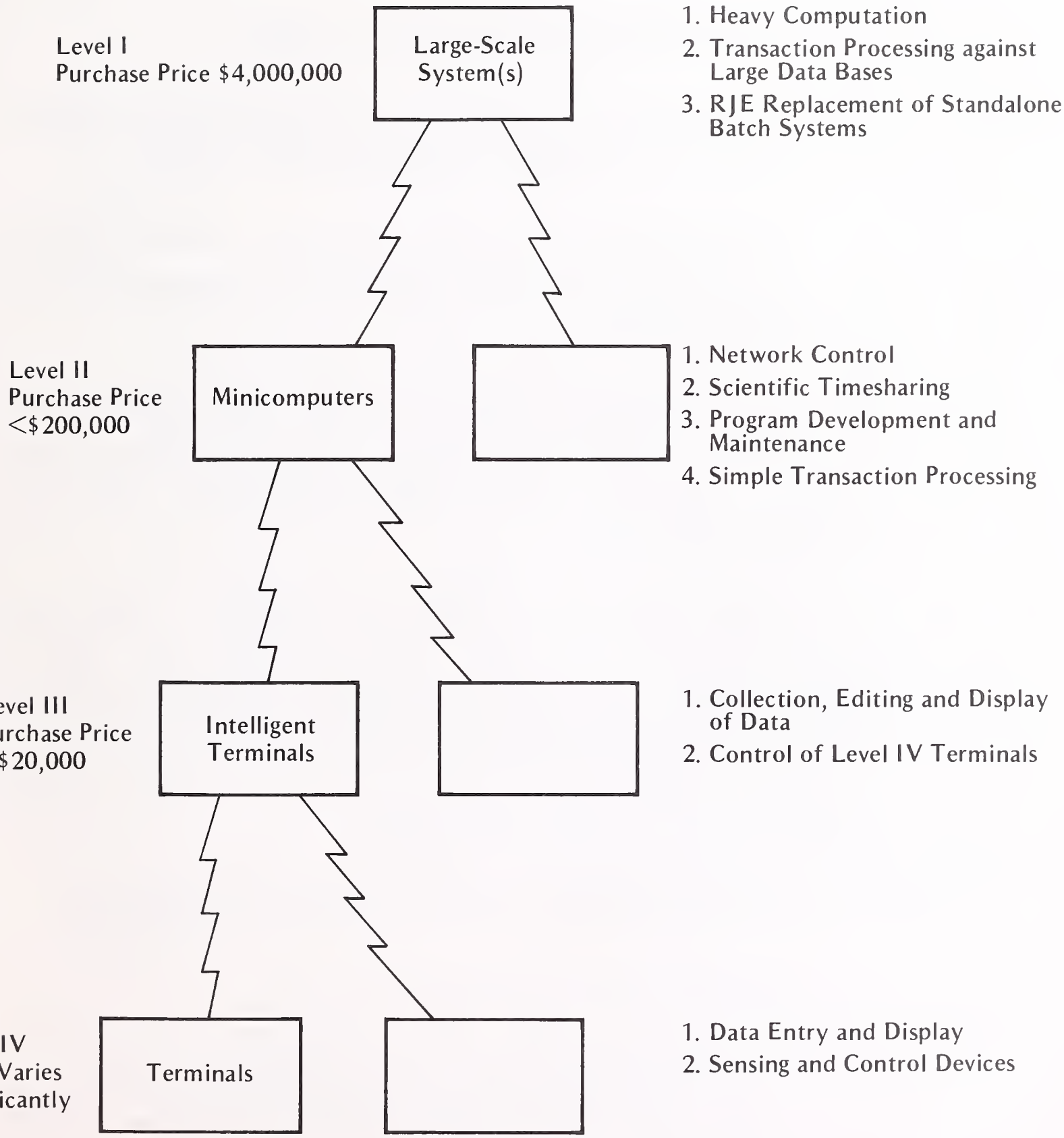
A. MAINFRAMES/MINICOMPUTERS/INTELLIGENT WORKSTATIONS

- Eight years ago, INPUT published a "proper" processing hierarchy for computers for computer/communications networks based on then current technology and economics (Economics of Computer/Communications Networks and their Future Impact, March 1976). The hierarchy at that time is depicted in Exhibit IV-1.

- The implication of this network was that only very large mainframes or minicomputers could be economically justified in large corporations.

EXHIBIT IV-1

HIERARCHICAL NETWORK



- An actual case study was presented in which 20 standalone computer systems (ranging from IBM System/3 up to 370/185s) were consolidated into a single center employing an IBM 370/165 and 168 processor.

  . Total data processing costs were cut in half.

  . The overall cost reduction was achieved despite significant reductions in terminals and communications services.

  . The savings came from reduced standalone computer costs (they decline approximately 70% over the implementation period) and personnel costs.

- The point was also made that the cost savings would become even more significant as the price/performance of large mainframes and minicomputers continued to improve (Amdahl was predicted to drive down very large-scale costs).

- SNA, which at that time was 3705-3790 oriented, was analyzed and found wanting, but from IBM's point-of-view, the main threat of distributed processing was to standalone batch systems, and SNA was designed to control the offloading of large mainframes. Therefore, its technical weakness could be viewed as solving a more important problem. There were also other problems:

  . The plug-compatible mainframe market was just developing.

  . IBM did not have a legitimate minicomputer.

  . The terminal market was in chaos, and IBM did not have either market share or technological control of intelligent terminal development.

. IBM had a well-deserved reputation for being weak in communications-oriented, interactive systems.

- The proper hierarchical network has held up pretty well over the years, and it would not be unfair to say that IBM's primary strategy in the last eight years has been to gain control of the development of computer/communications networks (distributed data processing). And IBM has been remarkably adroit and successful with this strategy. Among the things that have occurred are the following:

  - It narrowed the role of minicomputers by announcing the Series I on an unsupported basis and directing its customer base to other solutions for most of the assigned minicomputer functions (especially simple transaction processing - with IBM software there is no such thing as simple transaction processing).

  - Mid-range systems were given better price/performance than large-scale systems when the 4300 series was announced.

  - The 8100 was announced as a distributed processing engine (although it was really a 3790 replacement), and some customers took an expensive detour on the road to distributed processing.

  - IBM decided to compete on a hardware price/performance basis and made the remarkable discovery that there was elasticity of demand in the large-scale mainframe market.

  - It was also discovered that transaction processing against large data bases (using IMS under MVS) could create demands for processing power that could tax even the largest mainframe.

- The 3270 was announced and eventually became a de facto terminal standard.

- Essentially IBM attempted to retain most minicomputer functions for the large mainframes and keep intelligent terminals as illiterate as possible.

- In the meantime, despite IBM's best efforts, minicomputers propelled DEC to number two in the data processing industry, and names like Hewlett-Packard and Data General became as well known as Honeywell, Burroughs, and Univac. In addition, the microprocessors in intelligent terminals gave birth to the personal computers, and users found they could do for themselves what their data processing departments could not or would not do for them.

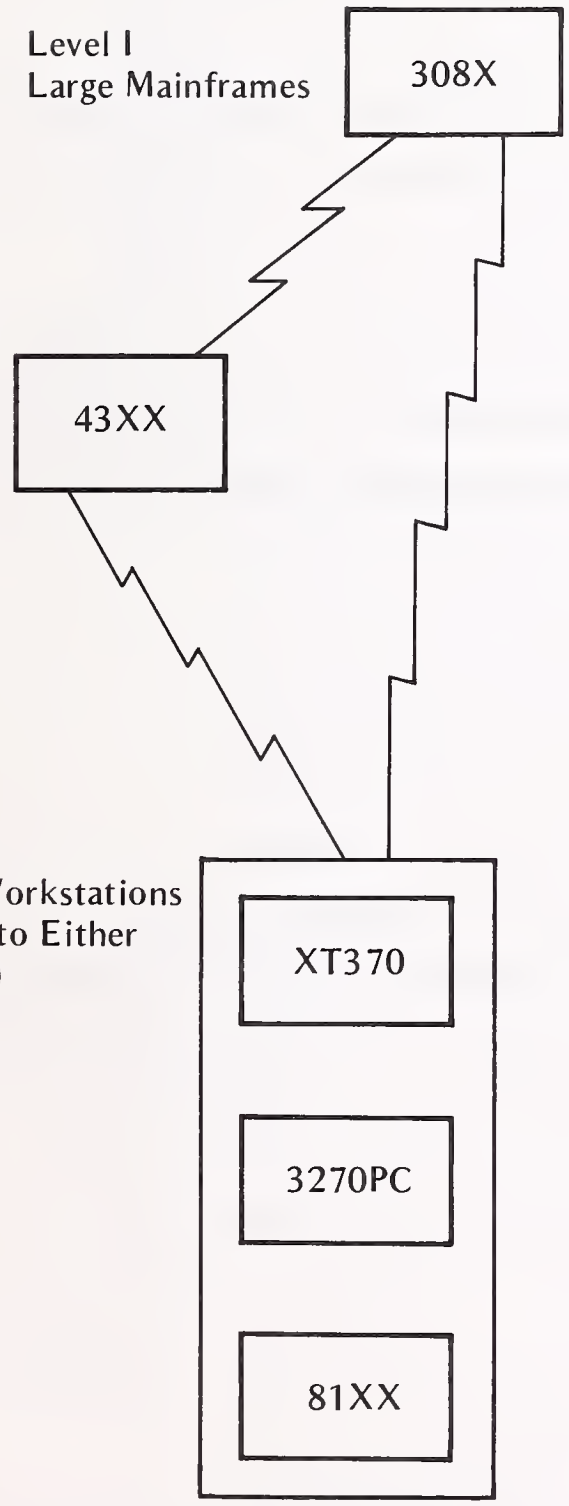
- IBM was forced to announce a personal computer because end users were suddenly beginning to get results that had only been promised through several generations of mainframe computer hardware and software (or at least they thought the results had been promised). In addition, personal computers posed a threat to IBM's terminal strategy - providing more function at lower price. The success of the IBM PC has been a remarkable case of turning adversity to advantage, and the October 18 announcements illustrate that a tactical breakthrough can also be exploited strategically.

- Essentially, IBM has bypassed (and overrun) the minicomputer by distributing processing down to the intelligent terminal level. IBM's version of distributed processing, in simplified form, is depicted in Exhibit IV-2.

  - The pressure that this strategy applies to the classic minicomputer functions becomes apparent. The minicomputer has practically been relegated to process control functions, which is where IBM has always tried to direct it.

EXHIBIT IV-2

IBM'S PROCESSING HIERARCHY



	Primary Functions
Level I Large Mainframes — 308X	1. Heavy Computation 2. Transaction Processing against Large Data Bases 3. Data Base Management for Network
Level II Mid-range Mainframes — 43XX	1. Local Data Base Management (for LAN) 2. Growth Path to Level I (4381 MUS/XA) 3. Direct Replacement of Minicomputers — Including Scientific and Engineering Processing (4361)
Level III Intelligent Workstations (Connected to Either Level I or II) — XT370	1. Professional Workstation 2. Program Development and Maintenance 3. Transaction Processing against Personal Data Bases 4. Level I and II Compatible Processing 5. PC Standalone
3270PC	1. Intelligent Workstations 2. Collection, Editing, and Display of Data 3. Processing against Multiple Local and Remote DBs 4. PC Standalone
81XX	1. Cluster Controller 2. Document Interchange 3. OA Interface
Level IV Terminals	Various Input, Output, and Sensing Devices

- The personal computer has demonstrated that microprocessors have the power to perform all of the calculations required for most business applications, including the development and maintenance of mainframe computer programs. The XT 370 is positioned to provide those capabilities and also to take advantage of 370 applications programs.

- The 3270 PC provides the type of multifunction workstation capability that will be required for the effective distribution of data bases over the processing hierarchy.

- The 8150 (which was announced along with the XT 370 and 3270 PC) will provide for interfacing between mainframe data bases (including document storage) and incompatible terminals and workstations associated with mainframes and office products.

B. SOFTWARE AND DATA BASES

- The intelligent workstations will provide more than enough processing power for most applications at the desk top, and they will do it at a fraction of the cost of mainframes. (A one-MIPS processor at $10,000 would be one-twentieth the cost of the 308X series.) However, there are limitations:

  - They cannot run mainstream IBM systems software (MVS/XA).

  - They do not have sufficient storage for large data bases nor the power to run IBM's major data base system (IMS).

  - Data base entry and maintenance through a keyboard is impractical for any except the smallest personal data bases, and, in addition, is extremely expensive even if the operator is a Harvard MBA and not yet the vice president of finance.

- While PC processing power may be sufficient and cheap, it is frequently impractical if the particular application will run for hours as opposed to minutes on a mainframe.

- Therefore, the large mainframe is not going to die, regardless of how much routine processing is distributed. In fact, it is easy to make a good case that even the largest current mainframe will not be sufficient to handle the requests for data that will be generated from the Level III intelligent workstations. Consider the following scenario.

  - Since the workstation user is being encouraged to do his own systems work, and prototyping is now in vogue, the requirements for data change - flexibility and ease of use - are the order of the day.

  - Everyone agrees that the relational data model has substantial advantages in those areas even if its performance has traditionally been a problem. Performance on a PC is not too much of a problem because storage limitations restrict data base size, and the user will initially be working on rather simple problems. Therefore relational data base systems are highly appropriate for personal computers.

  - Now the XT 370 user who has become accustomed to the flexibility and ease of use of his relational system gets tied into the large host and a great wealth of corporate data theoretically becomes available. Unfortunately, it is all in an IMS data base or VSAM and sequential files.

  - This is no problem. In June 1983 IBM announced DB2 for MVS/XA and MVS/370 architectures, and along with it data extract facilities to build relational tables. IS management can provide up to 64 gigabytes of relational data base for all those hungry users.

- Now the user can browse through the available host data and ask for some of it to be pumped down-line in a usable format. And the first time he executes a JOIN and SELECT (basic relational operations) on two large relational tables, your 3084 is probably going to come to a screeching halt. Then try to explain why such a simple request presents such a problem.

C. HUMAN FACTORS

- The above scenario is only one of numerous possibilities, but they all have the same themes:

  - PC users are going to expect performance and cost of host facilities to be comparable to the perceived performance and cost of their PC.

  - Demands upon the host system may not be reasonable by IS standards, but they are certainly predictable.

  - PC users will be more patient with their own systems than they are with host performance and cost.

  - The demands on the host are going to expose the complexity and overhead of mainframe systems software, and this will be extremely difficult to justify to the end user's satisfaction.

- In other words, users are going to continue to question why large systems (and the supporting IS function) are so unresponsive and costly. The question is only natural and human, and after all these years IS management should know it.

D. WHAT IS THE RESIDUAL VALUE OF A DINOSAUR?

- Over the years large-scale IBM hardware/software systems have been compared to dinosaurs and doomed to extinction. In fact, INPUT has raised this specter in the past. If the large mainframe does go the way of the dinosaur, there will be only a limited market (even in zoos and museums), and residual values will obviously be affected severely.

- Fortunately, it seems that IBM's latest approach to distributed processing (whether by accident or design) makes a lot of sense. The tools to maintain control of a corporate resource (information) have been provided, and the large mainframe solution can be most cost effective if the total costs of information management are objectively analyzed on both a centralized and decentralized basis. This is the challenge for IS management.

- Specifically, it is INPUT's opinion that the migration of functions from the mainframe to intelligent terminals will prove cost effective if properly handled on an orderly basis, and that the economics of managing a large data base on a central basis is more economical than distributing such costs to operating budgets by the uncontrolled installation of either minicomputers or personal computers. In other words, IBM's processing hierarchy supports the maxim that processing can be most effectively accomplished on either very large or very small processors.

- The possibility that large mainframes will become extinct has been considered and rejected in the residual value forecasts that follow. Indeed, INPUT anticipates that the burden on large-scale IBM mainframes will be such that IBM will announce a more powerful mainframe in the third or fourth quarter of 1984.

V PROJECTED RESIDUAL VALUES OF IBM AND SOFTWARE-COMPATIBLE MAINFRAMES

- Computer equipment residual value forecasting is based upon:

  - Analysis of historical events and trends leading to judgments about whether (and in what way) such trends may change. (It is INPUT's conclusion that the economic justification for a change in the processing hierarchy does exist but that the future of large-scale mainframes remains secure.)

  - Predictions by computer industry experts on expected actions by IBM and responding strategies by both software-compatible mainframe manufacturers and vendors of alternative technical solutions.

  - Analysis of variables affecting residual values as listed in Exhibit V-1.

- Projected future values for IBM, Amdahl and NAS mainframes are presented in table format in Exhibit V-2. Graphical presentations of projected values for selected mainframes are presented for the following mainframes in Exhibit V-3 through V-17.

  - IBM: 3033, 4331, 4341, 4361, 4381, 3083 E, 3083 J, 3081 G and 3081 K.

  - Amdahl: V8, 5860, 5880.

  - NAS: 6000, 8000, 9000.

EXHIBIT V-1

FACTORS AFFECTING COMPUTER EQUIPMENT RESIDUAL VALUES

- IBM practices and policies
  - New product announcements
    - . Price/performance ratios relative to existing products.
    - . Ease of conversions, transitions, and lead time in obtaining new products.
    - . Ease of installation and maintenance.
    - . Effect on perceptions about IBM's technical direction.
  - Pricing policies
    - . Price increases or decreases on existing products.
    - . Rental versus purchase break-even ratios.
    - . Lease plans and penalty provisions for lease termination.
    - . Purchase option accruals.
  - Maintenance policies
    - . Availability and cost.
    - . Attitude toward other vendor modifications to IBM equipment.
- Alternative equipment services
  - Price/performance of plug (software) compatible alternatives.
  - Third-party leasing options.
- Other variables
  - Environmental support considerations, e.g., electrical power consumption, air conditioning needs, space requirements.
  - Tax considerations, e.g., income tax incentives such as investment tax credit and accelerated depreciation, and also property taxation rates.
  - General economic conditions, e.g., cost and availability of capital and overall demand for computing capacity.

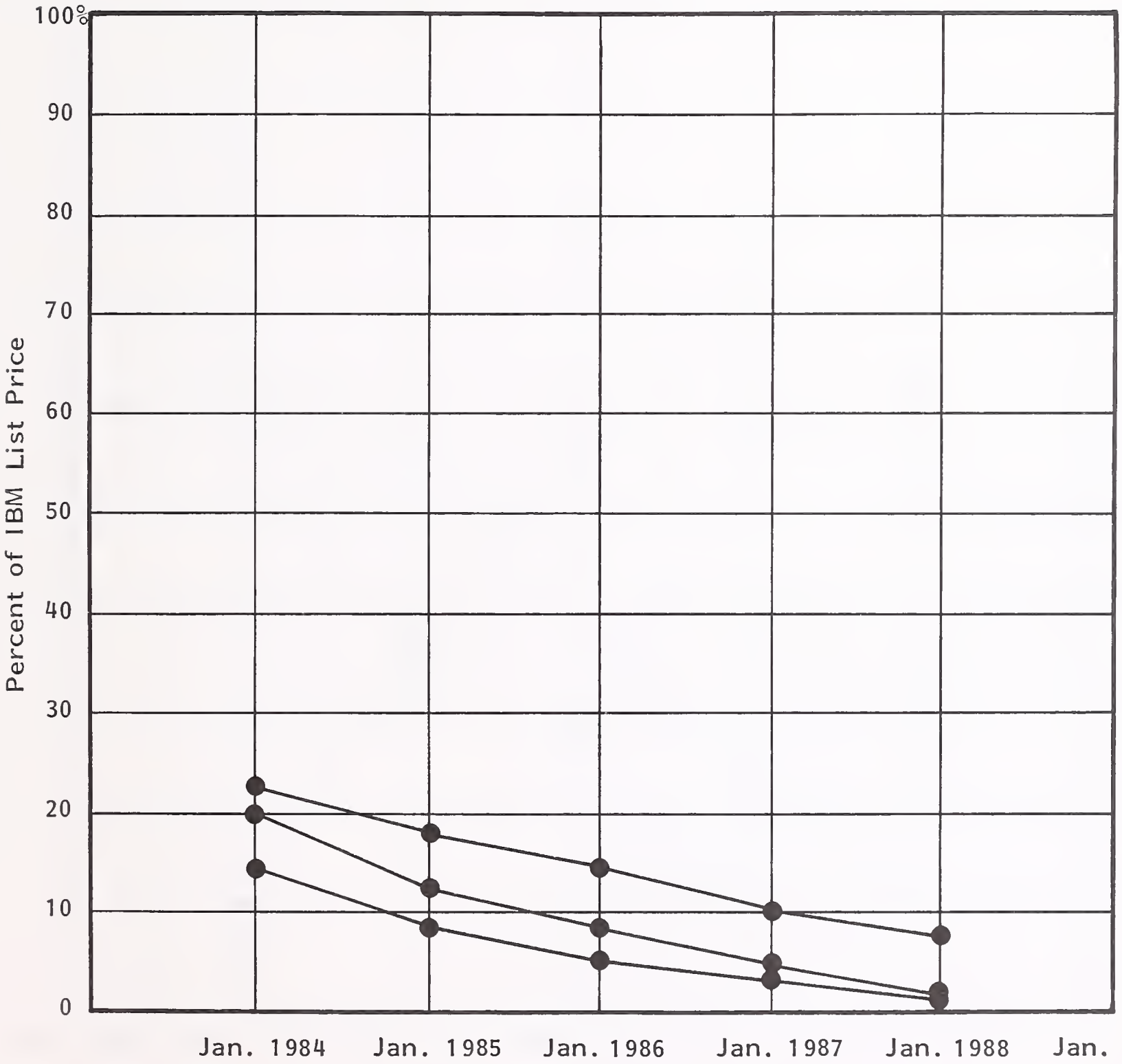
EXHIBIT V-2

PROJECTED RESIDUAL VALUES FOR
IBM AND SOFTWARE-COMPATIBLE MAINFRAMES

VENDOR	PROCESSOR MODEL	PROJECTED RESIDUAL VALUE AS PERCENT OF VENDOR LIST PRICE AS OF JANUARY 1				
		1984	1985	1986	1987	1988
IBM	4331-1	60	65	45	31	7
	4331-2	62	68	50	35	10
	4341-1	54	42	28	14	5
	4341-2	60	48	35	20	8
	4361-1	100	74	60	35	10
	4361-2	100	80	65	42	15
	4381-1	110	80	65	42	14
	4381-2	110	83	70	48	20
	3031-6	4	2	1	-	-
	3032-8	4	2	1	-	-
	3033-N	15	10	6	3	1
	3033-U	20	12	8	5	2
	3083-E	90	78	65	50	20
	3083-B	90	80	67	50	21
	3083-J	90	80	68	50	22
	3081-G	85	68	50	35	15
	3081-K	88	75	60	48	24
	3084-Q	90	78	62	50	27
AMDAHL	470-V/5	3	1	-	-	-
	470-V/6	5	3	1	-	-
	470-V/7	12	7	4	2	1
	470-V/8	17	10	7	5	2
	5860	80	57	40	24	15
	5880	100	80	52	37	18
NAS	AS/6620	62	50	28	14	5
	AS/6630	65	56	33	18	8
	AS/6650	70	60	35	22	12
	AS/8040	100	77	50	28	10
	AS/8050	100	80	52	31	14
	AS/8060	100	85	55	36	18
	AS/9040	55	36	20	9	5
	AS/9050	58	40	25	12	7
	AS/9060	65	43	30	18	10
	AS/9070	72	50	42	24	15
	AS/9080	80	60	50	30	18

EXHIBIT V-3

RESIDUAL VALUE FORECAST
FOR IBM 3033 PROCESSOR

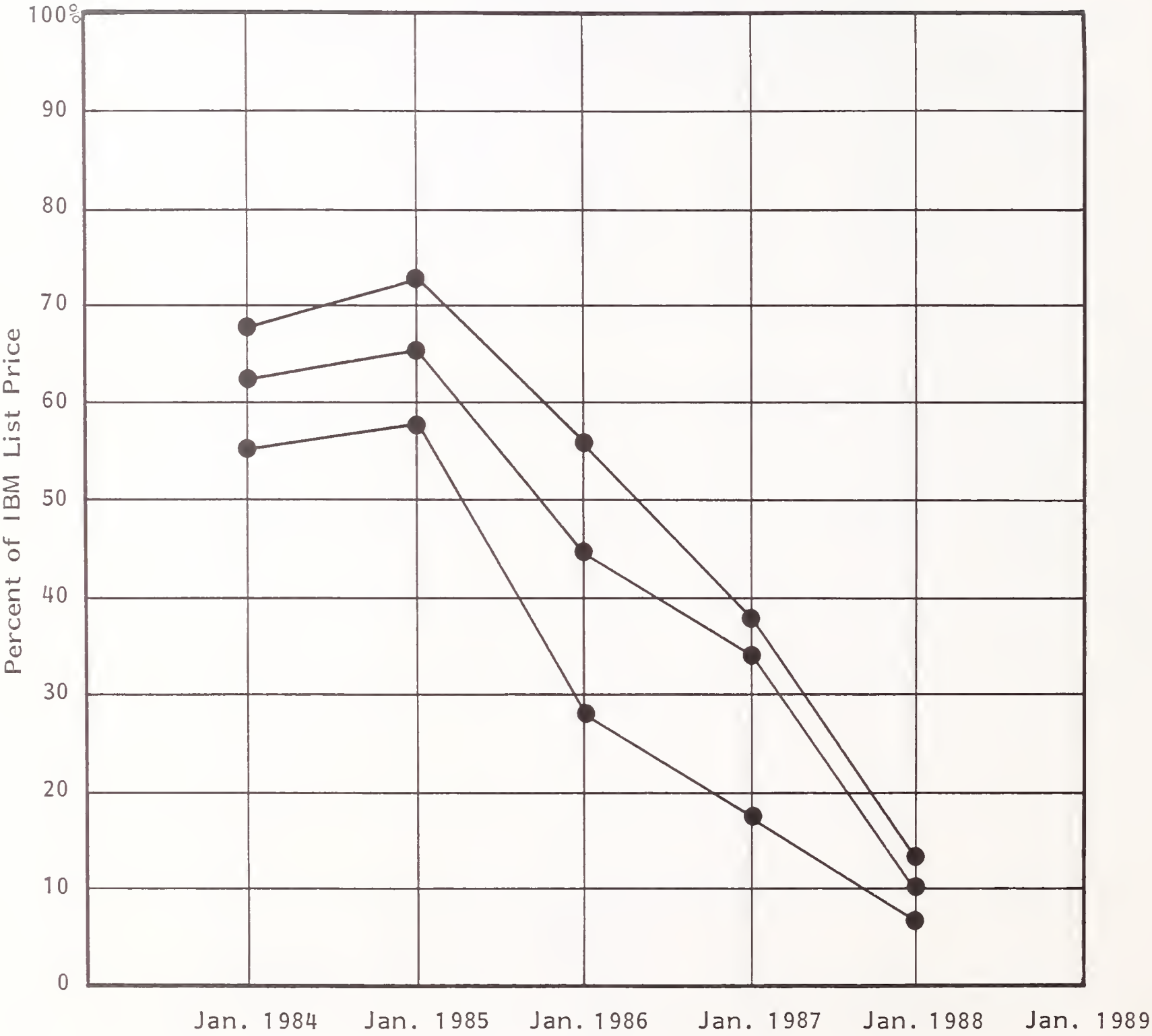


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	22	18	14	10	7
Expected	20	12	8	5	2
Low	15	8	6	3	1

EXHIBIT V-4

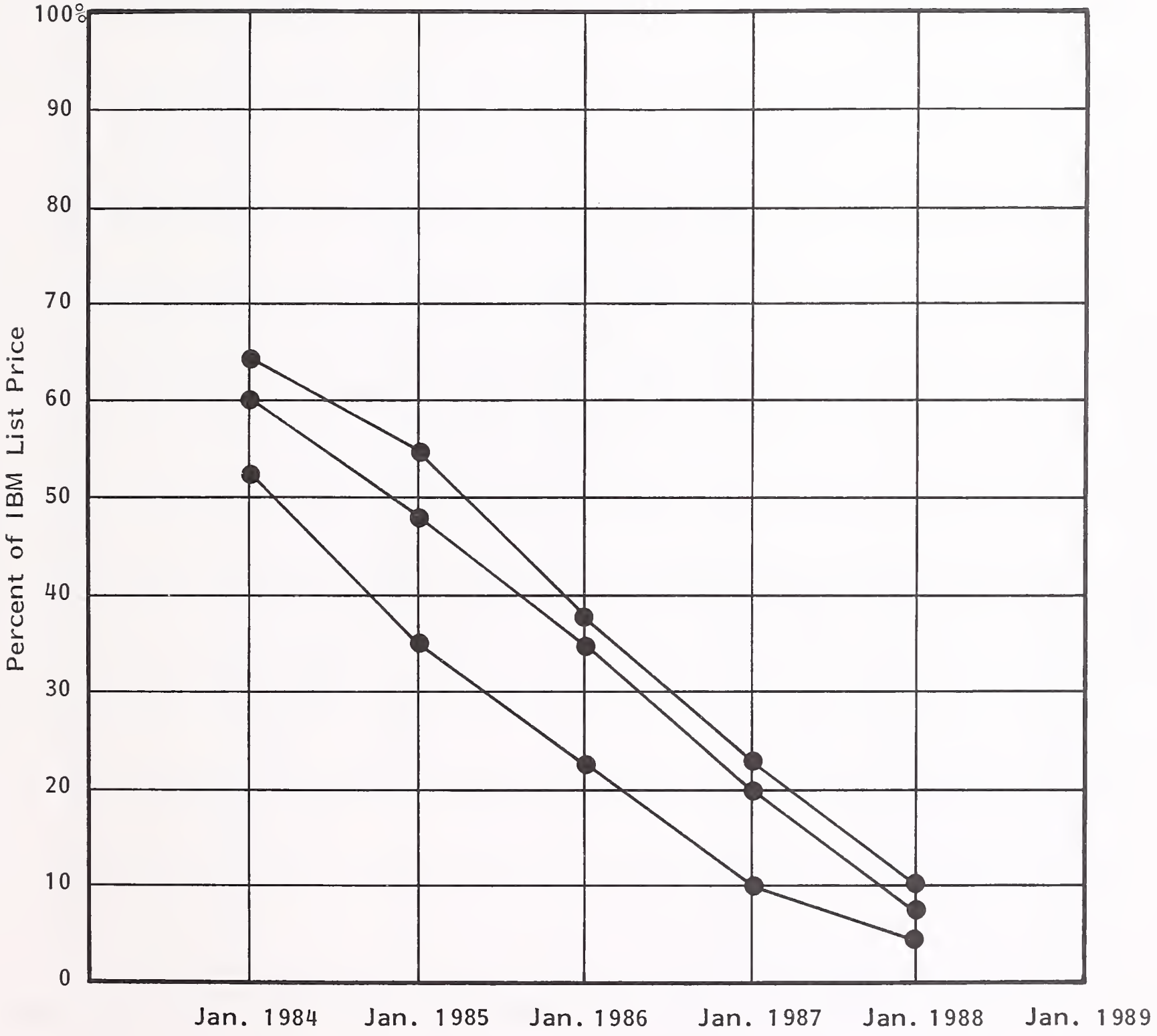
RESIDUAL VALUE FORECAST
FOR IBM 4331 PROCESSOR



As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	68	72	55	38	12
Expected	62	65	44	35	10
Low	55	48	29	18	6

RESIDUAL VALUE FORECAST
FOR IBM 4341 PROCESSOR

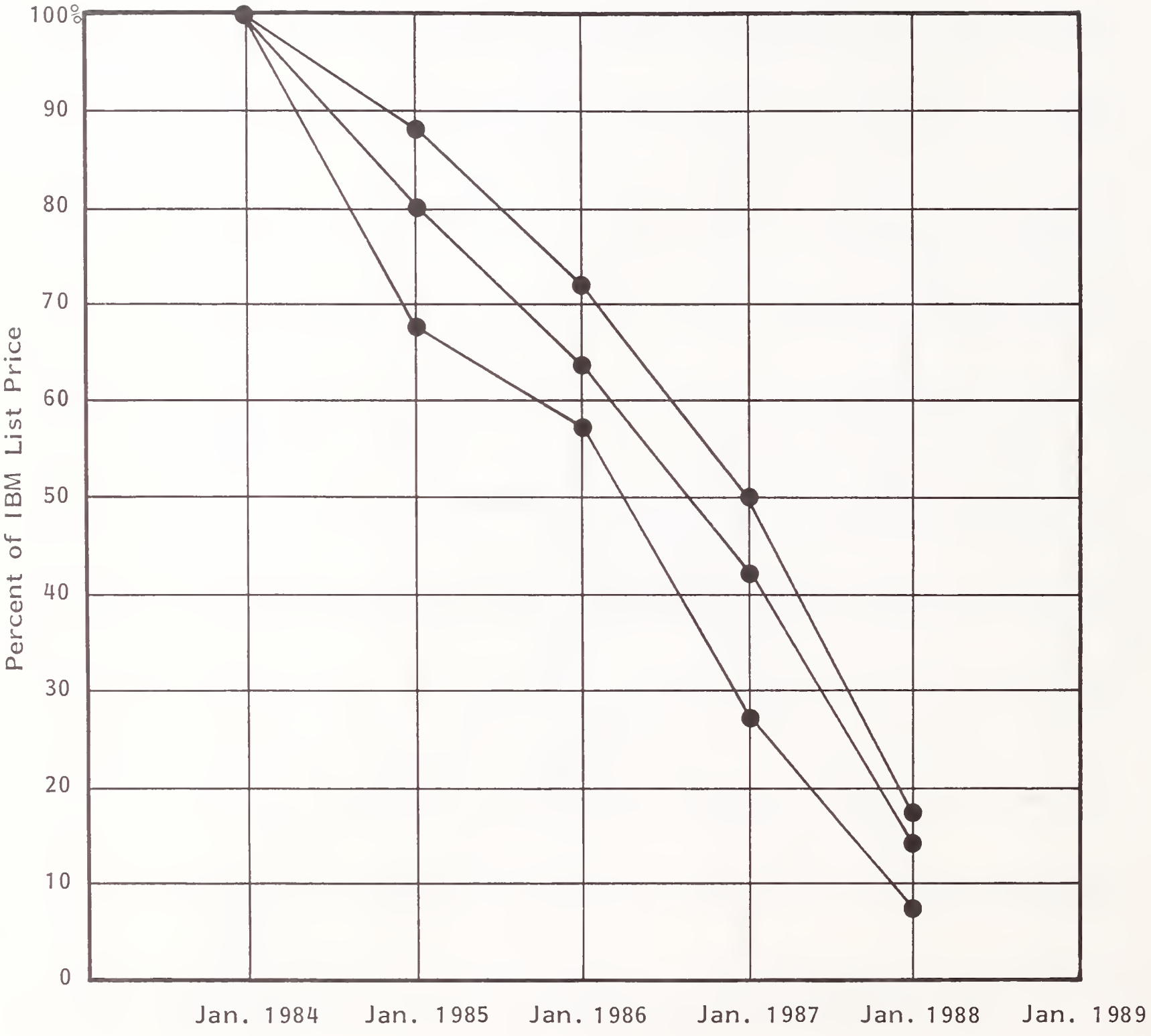


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	64	54	38	22	10
Expected	60	48	35	20	8
Low	52	35	22	10	5

EXHIBIT V-6

RESIDUAL VALUE FORECAST
FOR IBM 4361 PROCESSOR

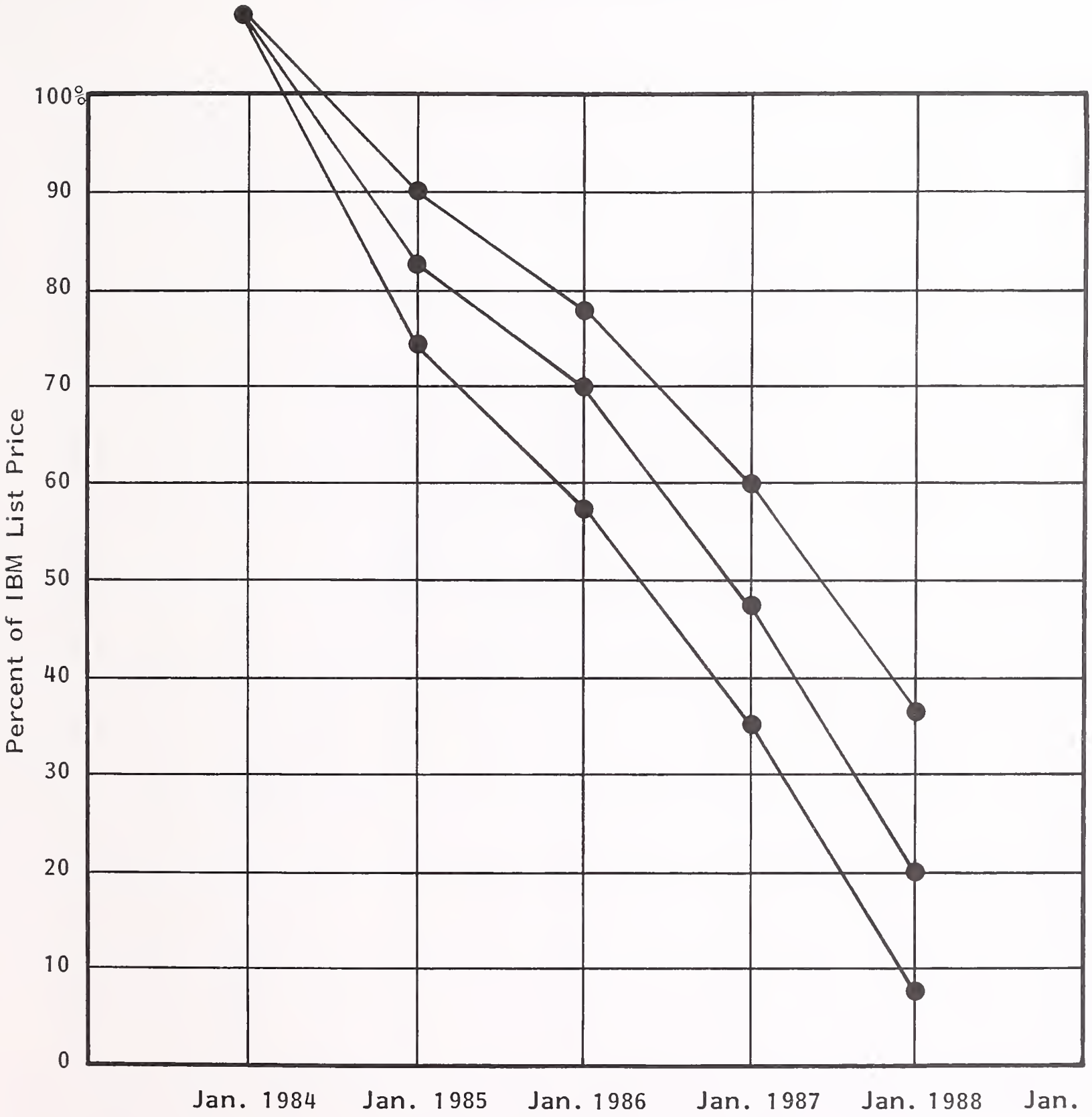


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		88	72	50	18
Expected	100	80	65	42	15
Low		68	57	28	8

EXHIBIT V-7

RESIDUAL VALUE FORECAST
FOR IBM 4381 PROCESSOR

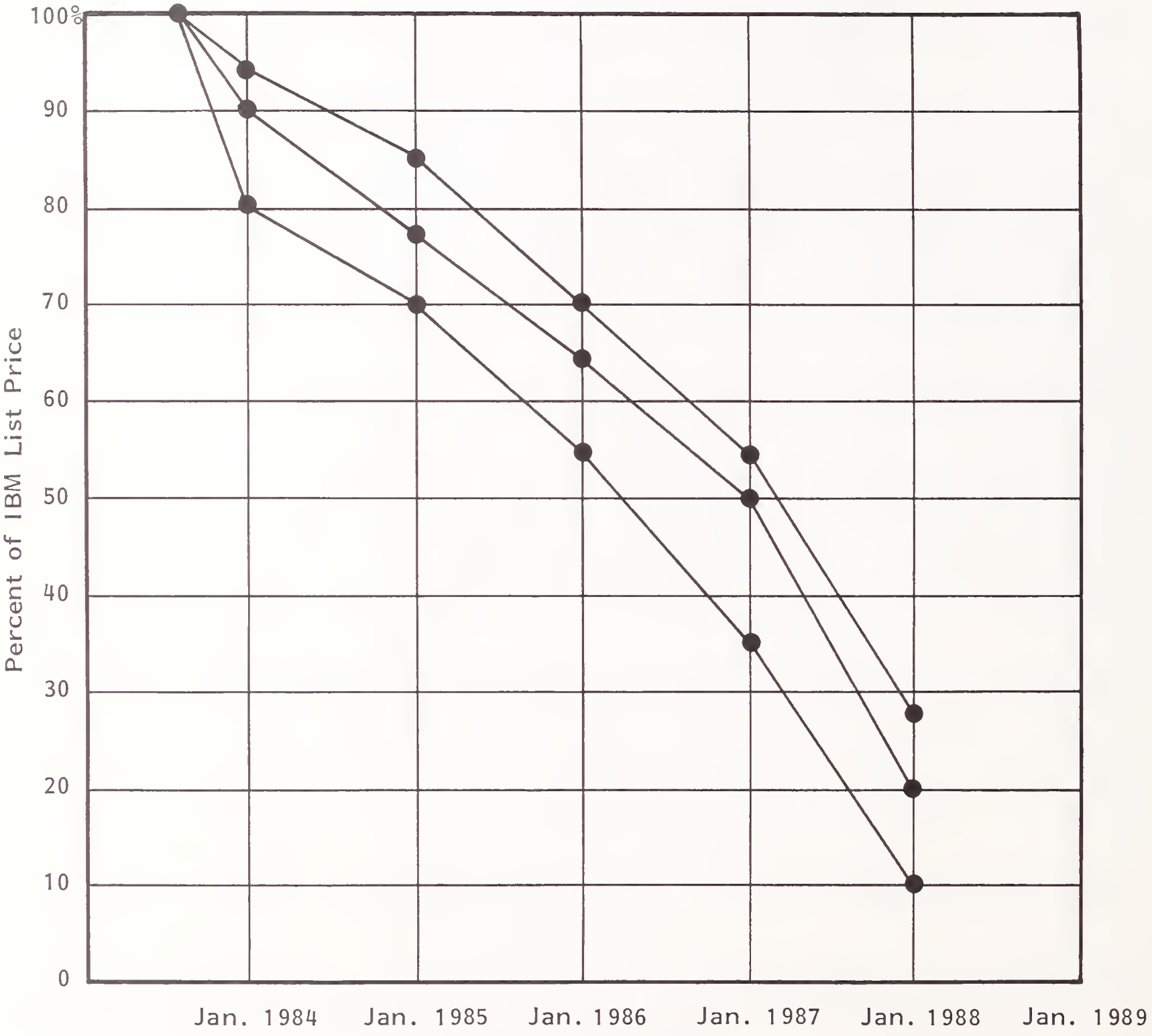


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		90	78	60	38
Expected	110	83	70	48	20
Low		75	57	36	8

EXHIBIT V-8

RESIDUAL VALUE FORECAST
FOR IBM 3083E PROCESSOR

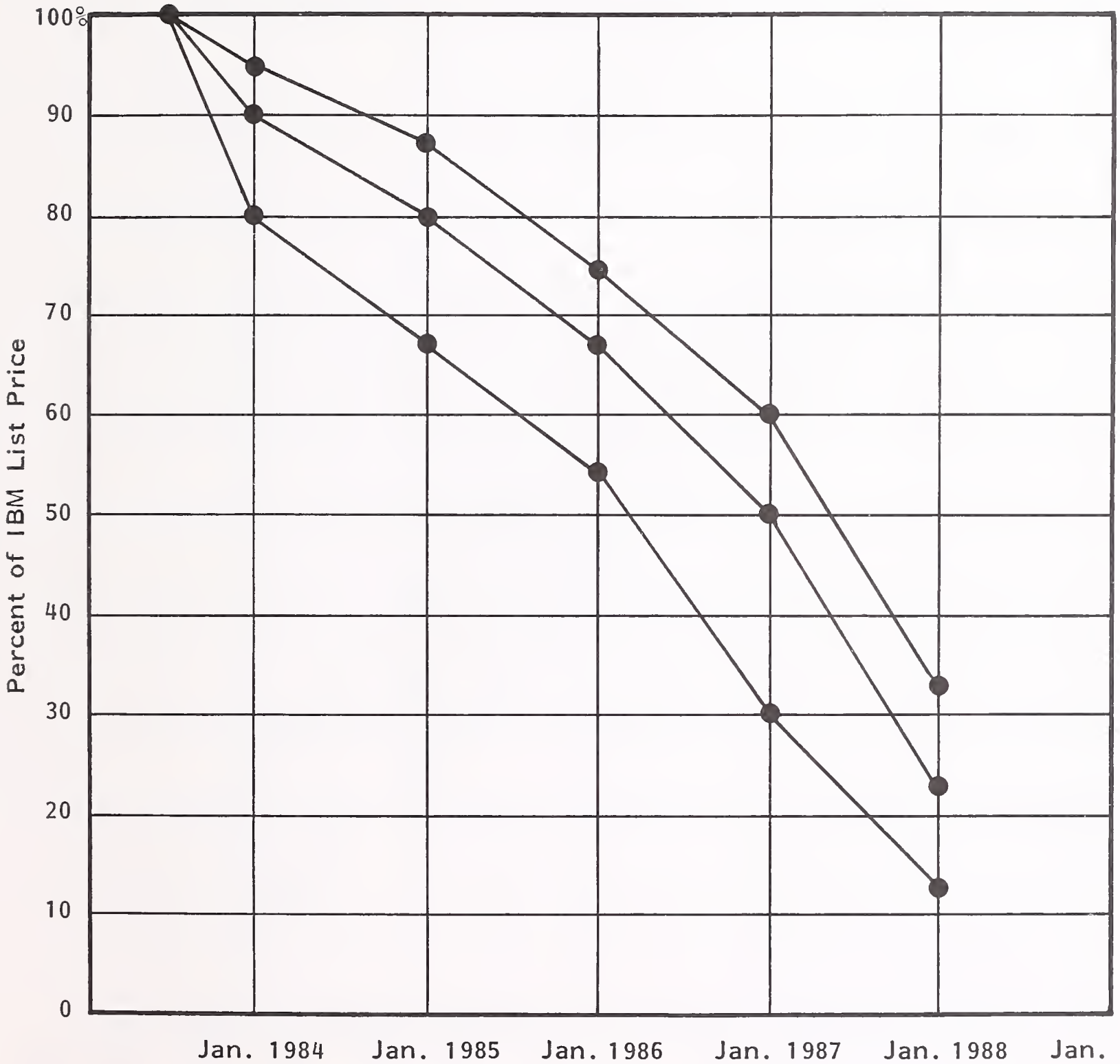


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	95	85	70	55	28
Expected	90	78	65	50	20
Low	80	70	55	35	10

EXHIBIT V-9

RESIDUAL VALUE FORECAST
FOR IBM 3083J PROCESSOR

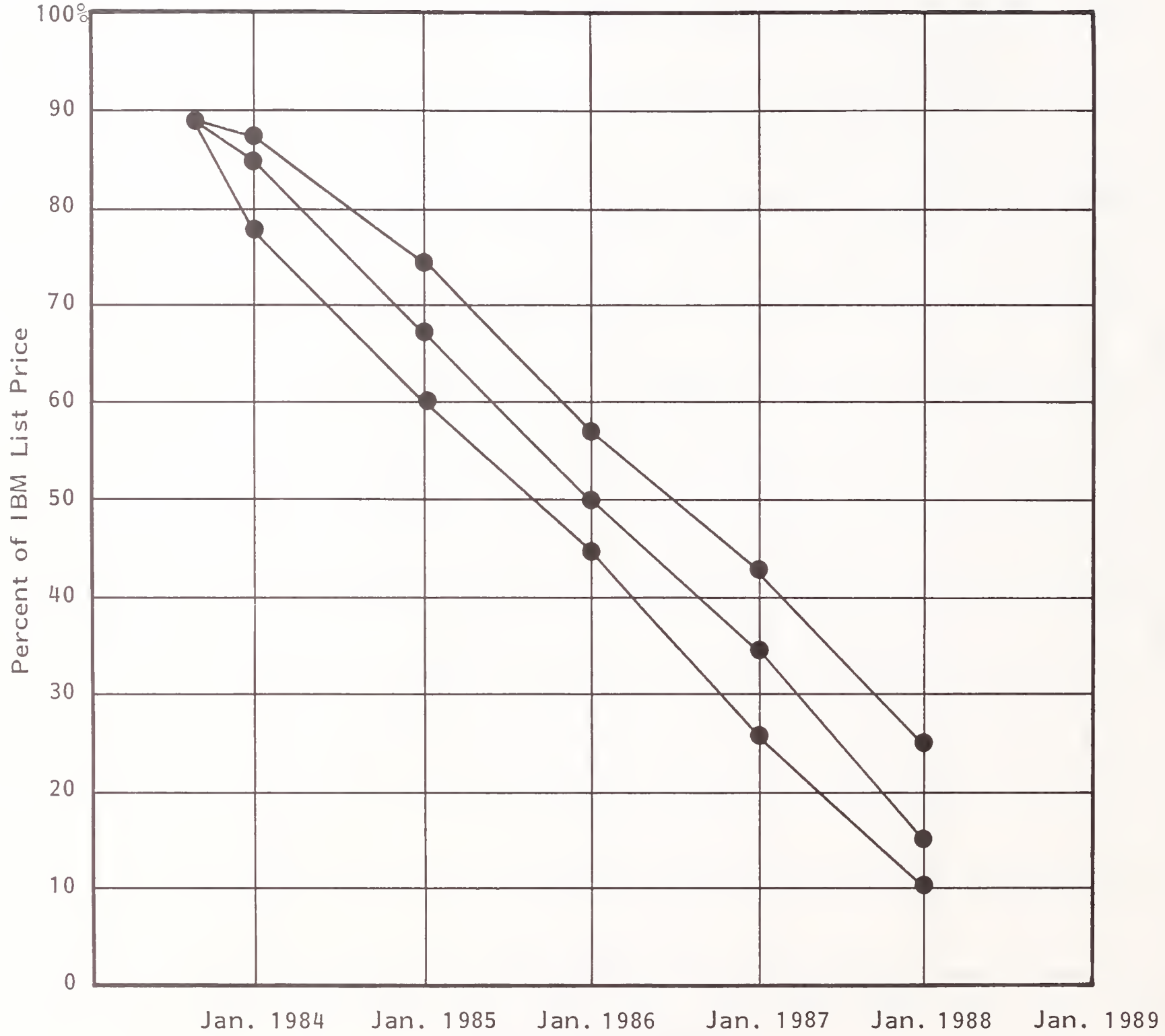


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	95	87	75	60	32
Expected	90	80	68	50	22
Low	80	68	55	30	12

EXHIBIT V-10

RESIDUAL VALUE FORECAST
FOR IBM 3081G PROCESSOR

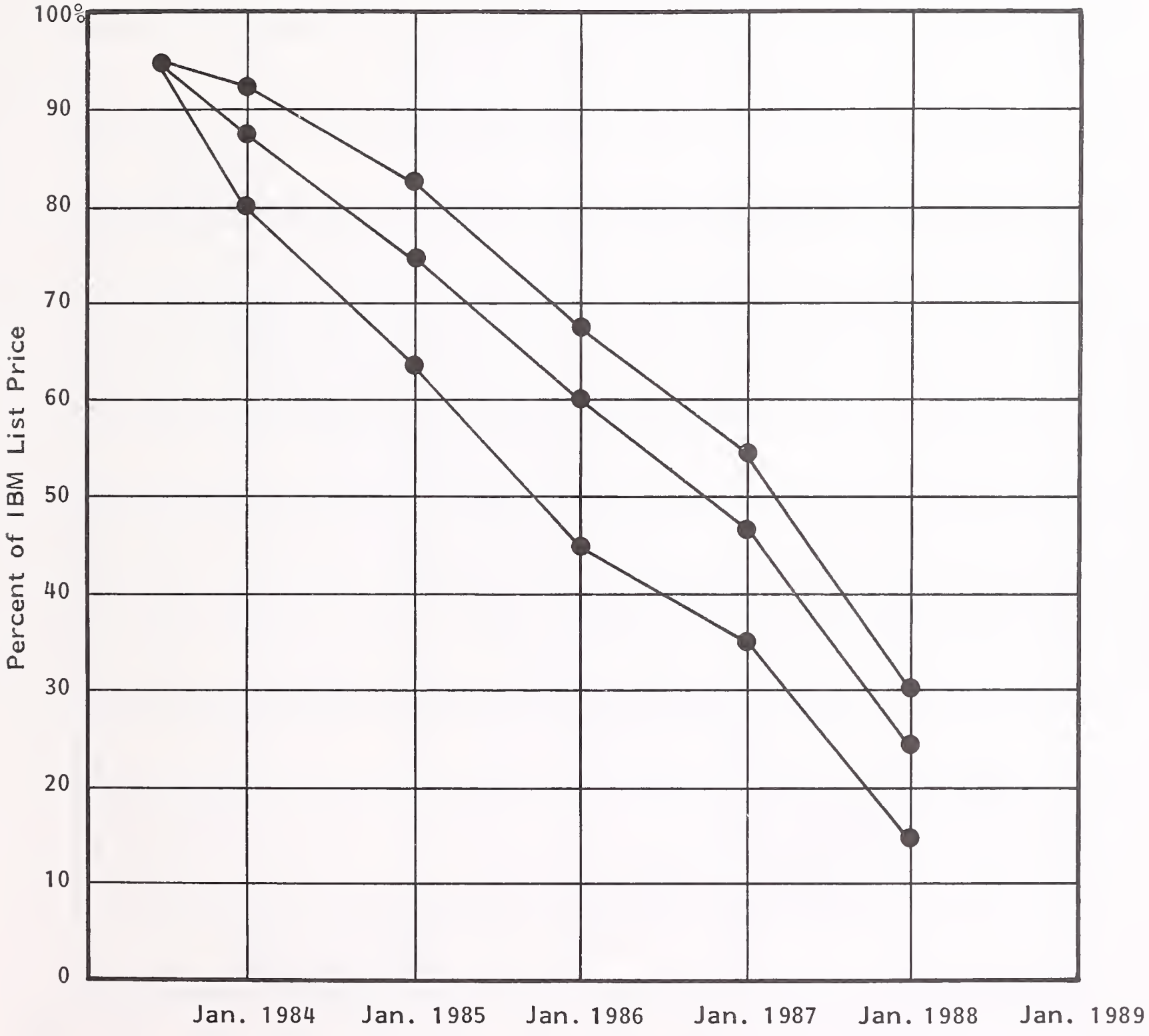


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	87	75	57	42	25
Expected	85	68	50	35	15
Low	78	60	45	26	10

EXHIBIT V-11

RESIDUAL VALUE FORECAST
FOR IBM 3081K PROCESSOR

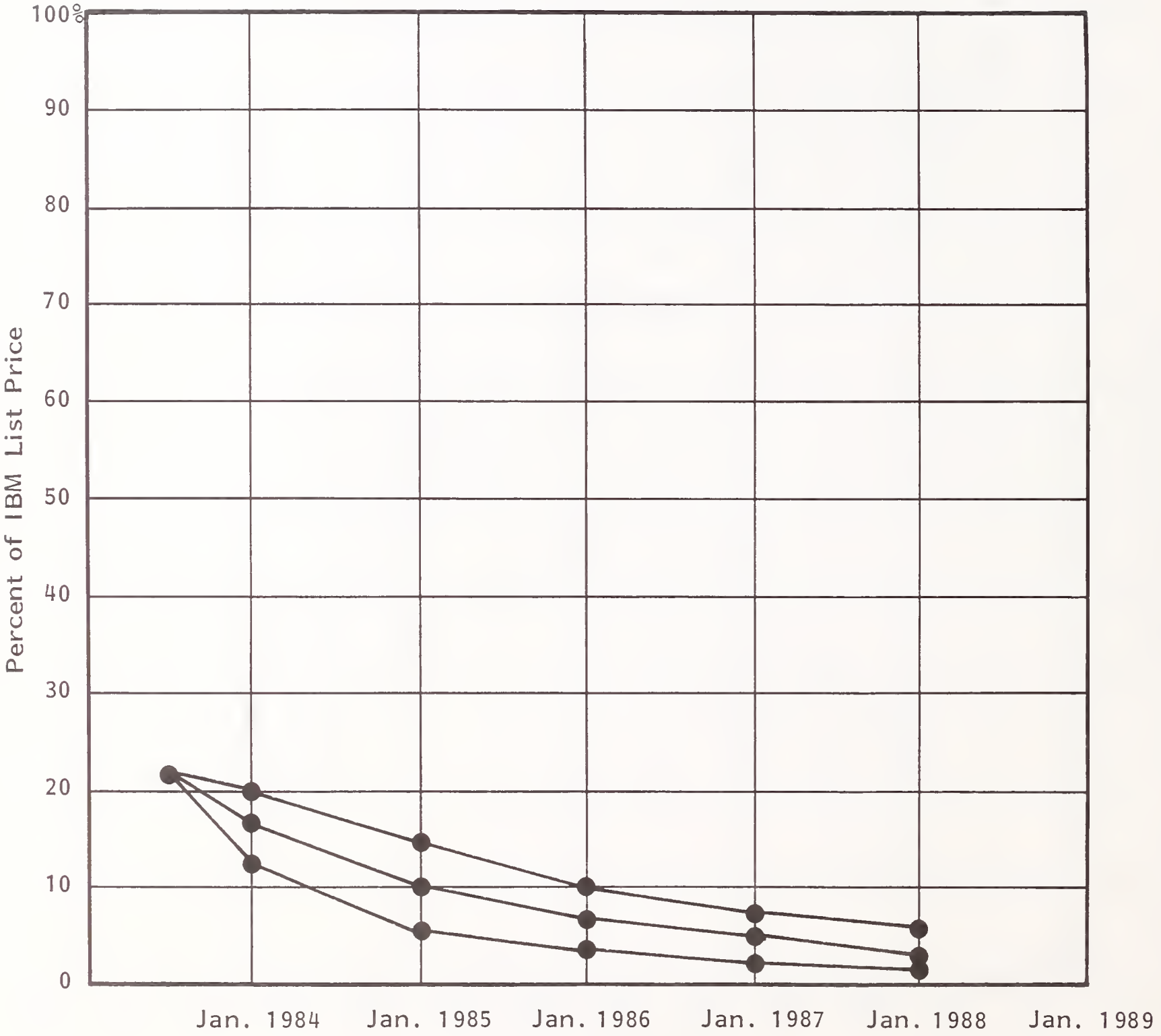


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	92	82	68	55	30
Expected	88	75	60	48	24
Low	80	63	45	35	15

EXHIBIT V-12

RESIDUAL VALUE FORECAST
FOR AMDAHL V8 PROCESSOR

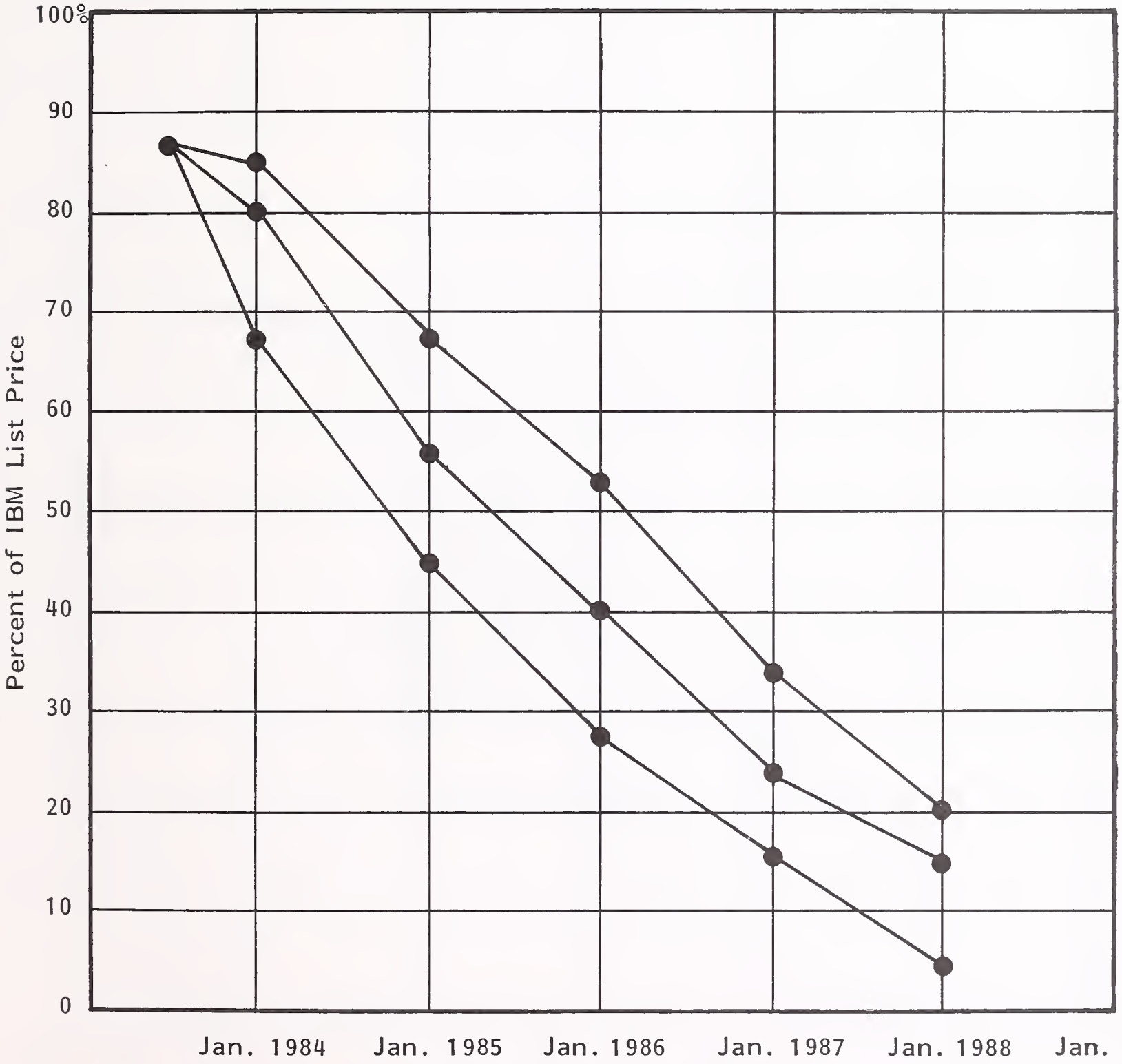


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	20	15	10	7	5
Expected	17	10	7	5	2
Low	12	6	4	2	1

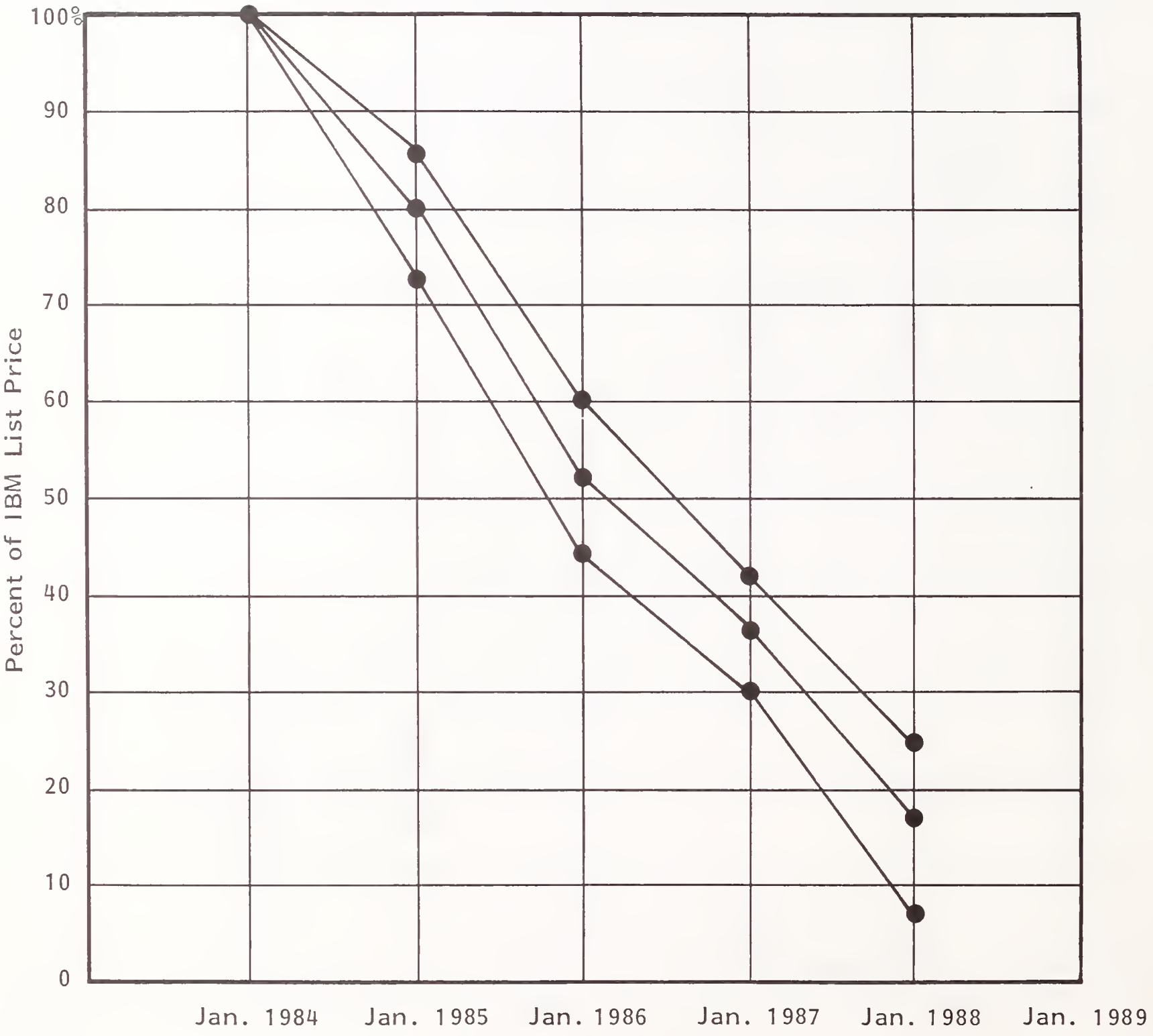
EXHIBIT V-13

RESIDUAL VALUE FORECAST
FOR AMDAHL 5860 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High	85	68	52	34	20
Expected	80	57	40	24	15
Low	68	46	28	14	6

RESIDUAL VALUE FORECAST
FOR AMDAHL 5880 PROCESSOR

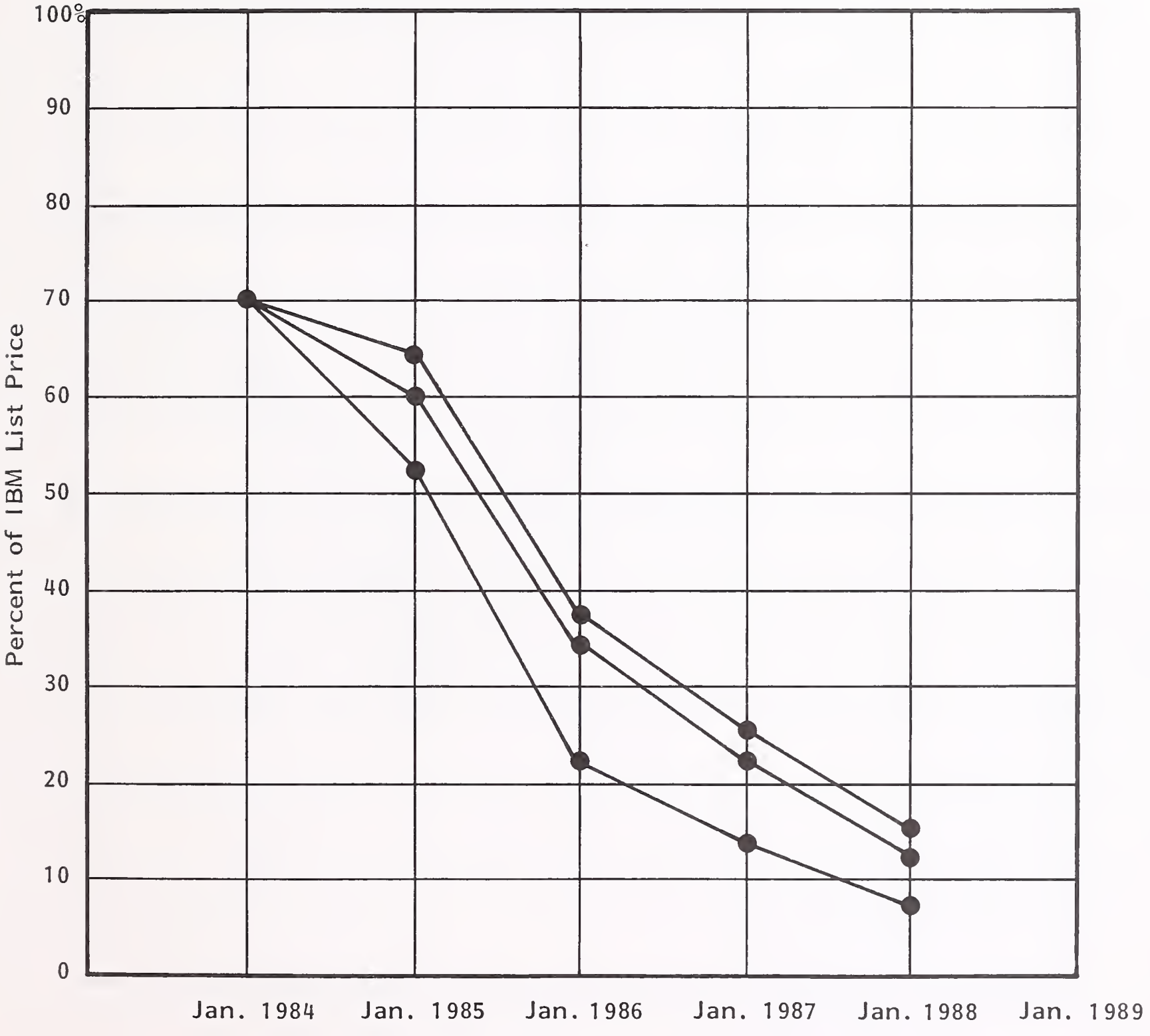


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		86	60	42	25
Expected	100	80	52	37	18
Low		72	45	30	8

EXHIBIT V-15

RESIDUAL VALUE FORECAST
FOR NAS 6000 SERIES PROCESSOR

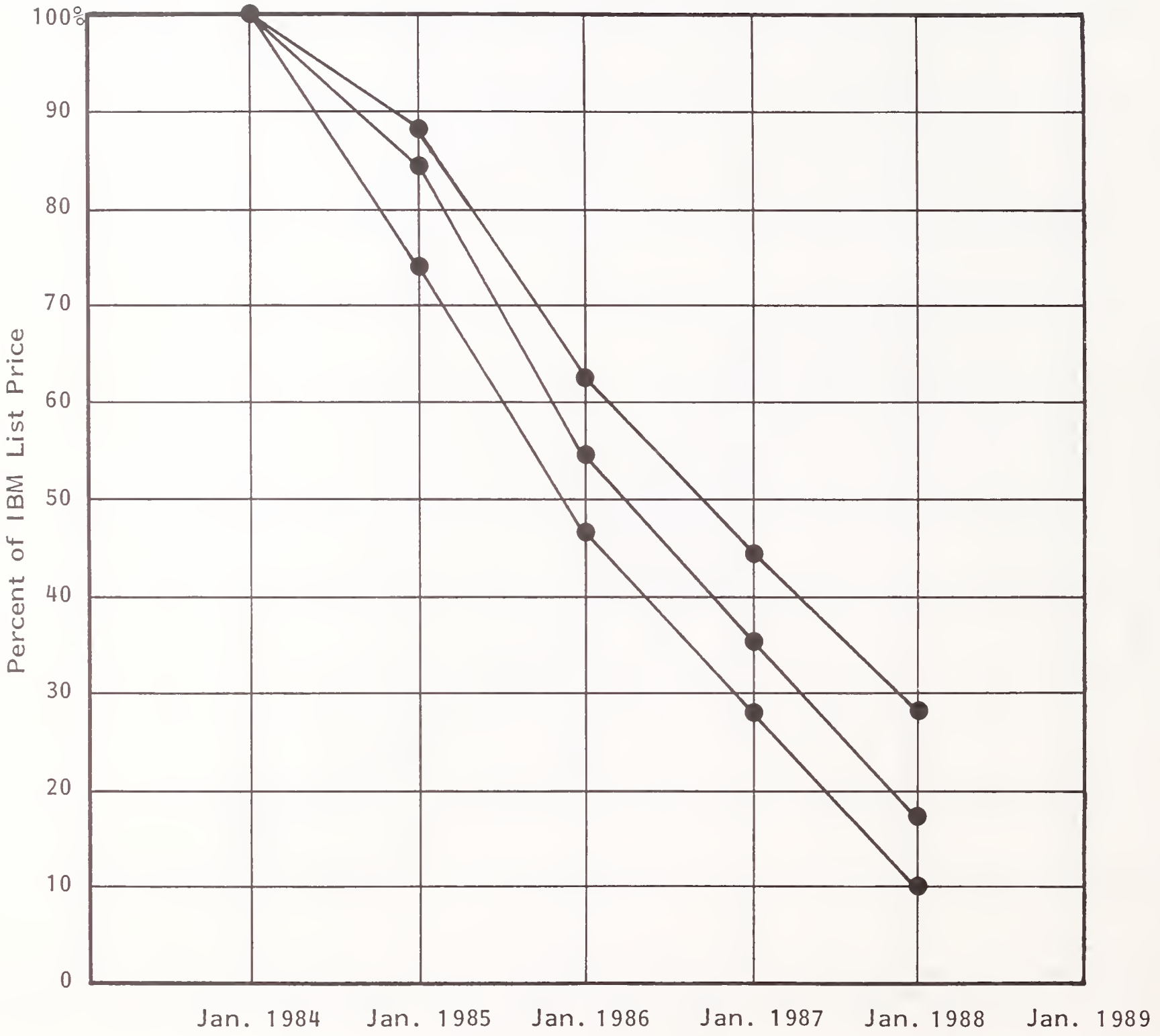


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		64	38	25	15
Expected	70	60	35	22	12
Low		52	22	13	8

EXHIBIT V-16

RESIDUAL VALUE FORECAST
FOR NAS 8000 SERIES PROCESSOR

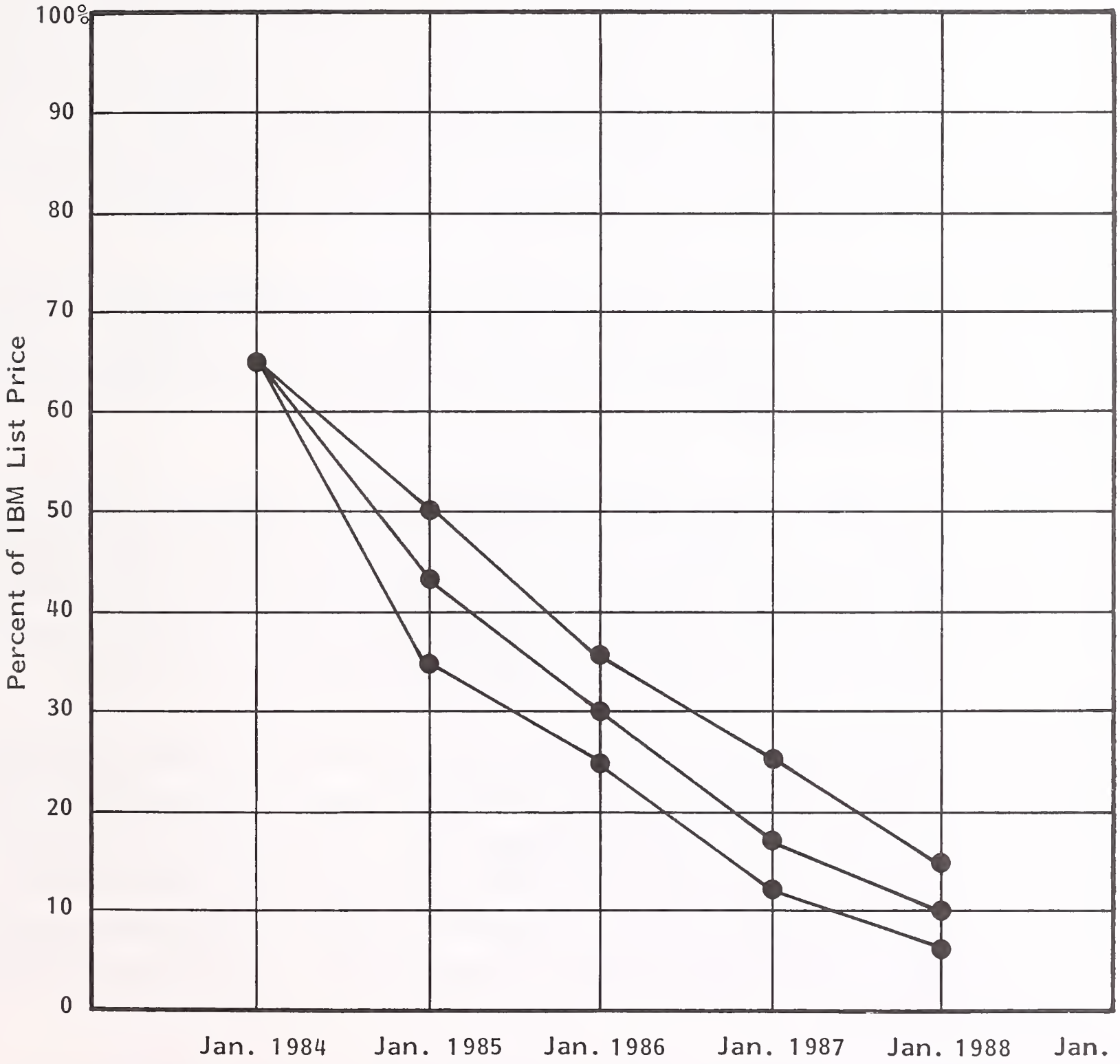


As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		88	62	45	28
Expected	100	85	55	36	18
Low		73	47	28	10

EXHIBIT V-17

RESIDUAL VALUE FORECAST
FOR NAS 9000 SERIES PROCESSOR



As of January 1, 1984

PROJECTED VALUES RANGE	JAN. 1984	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988
High		50	36	25	15
Expected	65	43	30	18	10
Low		35	25	12	7

- The values shown are wholesale prices - the amount a used-computer dealer will pay for equipment for subsequent resale to an end user at a higher price.

- The announcement of the 4361 and 4381 processors gives support to the price/performance estimate of $175,000 per MIPS for IBM's next product generation, which was made in the December 1982 residual value forecast report (see Residual Value Forecasts: Fall Update, November 1983). As mentioned previously, INPUT now anticipates that a more powerful processor (code named Sierra) will be announced as early as the third quarter of 1984.

- The fact that the IBM 4331 processors can be field upgraded to the 4361 has improved the residual values of that system relative to the 4341. These forecasts have changed significantly from those made in the fall update issued in November 1983.

- The residual values of NAS AS/8000 have also been adjusted to reflect more closely the list prices of those processors that were adjusted because of IBM price adjustments to the 3083 series. It should be pointed out that NAS list prices are difficult to determine, and the residual value is related to the price at which the vendor will sell the system rather than to a firm list price.

- Generally speaking, the used market for large-scale IBM mainframes (308X) has remained relatively strong, and residual values have been adjusted upward from the forecasts made in December 1983. The availability of the 3084 has provided a growth path for the 3081, which has significantly enhanced its value in the used market. In addition, the delay in delivery of the Amdahl 5880 has had a positive impact on the used market at the high end of the IBM line.

- A curious thing happened after this report was completed - IBM gave securities analysts rather specific revenue projections for 1984 (Wall Street Journal, December 9, 1983) and projected 308X mainframe shipments would increase by 18% in 1984 (compared to overall sales growth of 14%). This seems to confirm INPUT's general analysis of the 308X market.

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